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THE offices of the RAILROAD AND ENGINEERING JOURNAL were on May 1 removed from No. 45 Broadway to No. 145 Broadway, on the corner of Liberty Street. The correct address of the JOURNAL will therefore be hereafter No. 145 Broadway, New York City.

UNTIL recently the quickest passage on record across the Atlantic Ocean was made by the *Etruria*, of the Cunard Line, in September, 1888, the time being 6 days, 2 hours from Queenstown to New York. This has now been beaten by the new Inman Line Steamer, *City of Paris*, which arrived in New York, May 8, having made the run from Queenstown in 5 days, 23 hours and 7 minutes. The distances made on each day of the voyage, by the ship's log, were: 445 miles; 492; 504; 505; 511; 398; total, 2,855 miles. The average per day was thus 478.77 miles; the average per hour for the whole voyage, 19.95 miles; and the average per hour for the best day's run was 21.28 miles. The weather was generally good except on one day, when a slight shifting fog forced the vessel to slow down several times. The engines averaged about 88 revolutions per minute, and the coal consumed averaged 320 tons per day.

The *City of Paris* is a sister vessel to the *City of New York*, of the same line, which was described and illustrated in the JOURNAL for September, 1888, page 411. There are some minor differences, but the general dimensions and arrangements are the same. The *City of Paris*, however, has made this exceptional run on her second westward trip across the Atlantic, while the *City of New York* has so far made no remarkable time.

THE Paris Exposition has been duly opened according to the programme, and from all the accounts received promises to be a very successful one. As appears to be universally the case with such Expositions, much still remained to be done on the opening day, but the work of reducing the different departments to order was proceeding very rapidly, and probably by this time everything is in proper shape. The exhibit of the United States, of which

some description will be given hereafter, is a very creditable one, although not so extensive in some departments as had been hoped for.

A REMARKABLE example of what may be accomplished at very small expense under intelligent direction, may be found at the Lehigh University, where the appropriation of an old wooden building, disused for other purposes, and the expenditure of a few hundred dollars has made what may be called an hydraulic laboratory, exceedingly valuable for practical instruction and also for the purpose of making tests. Of course a better arrangement could have been made had there been more money at the disposal of Professor Merriman, who was the designer and architect, but the very best use has been made of the means available, with results that are well worth inspection. In this little building observations are made as to power developed by turbines, consumption of water, and many other practical points of much use to the hydraulic engineer. The great drawback at present is the absence of a proper reservoir in which water can be stored, so that in a dry season the use of the building is limited by the supply of water.

THE running of Sunday trains has been a subject of some discussion and considerable agitation lately. The American Sabbath Union some time ago issued a circular in relation to running Sunday trains, to which responses were received from a large number of railroad officers, the majority favoring the suspension of Sunday work. The question has been taken up by some prominent railroad lines, and President Depew, of the New York Central, has announced that on that line the running of all Sunday trains, unless strictly necessary, is to be suspended.

With the present organization of our social and economical system a complete stoppage of trains on Sunday does not appear to be possible, especially in the neighborhood of our large cities; but it does seem as if a great deal of the work now done on the first day of the week might be avoided. The railroad man ought to have his day of rest as well as any other American citizen, and by proper management it could be secured to him. That he would be benefited by his Sunday off there can be no doubt, for hardly any class in the community is, as a rule, more intelligent or more ready to take advantage of opportunities.

UNIFORM SAFETY APPLIANCES ON RAILROADS.

THE Interstate Commerce Commission has issued a circular—reprinted on another page—which may be regarded as the first reconnaissance in a contest which will probably last for some time, and may be exciting before it is ended. At present there are probably 2,000 railroad employes killed and 10,000 more or less seriously injured annually on the railroads of this country. That railroad companies and their officers will resent any interference which will compel them to give greater protection to the lives and limbs of their employes may be expected. Not that such officials have less humanity than any other class, but mankind generally, and especially that part of it which is placed in official position, is prone to make for itself little puddles of prejudice, ignorance, and indolence in which it loves to wallow, and is quite sure to resist being disturbed, no matter how urgent the reason is for doing so.

The fact that traffic is now not only national but international—that cars from California may be found in New Brunswick, and that those whose home is near the Halls of the Montezumas—metaphorically speaking—are at times sheltered under the ramparts of Quebec—is reason why the question of railroad safety appliances cannot be adequately controlled by local State commissions, but should be under interstate or, perhaps, international authority. To secure the adoption of uniform safety appliances all over the country is a very big contract, and the Interstate Commission will find that the difficulties in the way of accomplishing that end are very great. In the first place, it is not easy to know what should be done. Who is there who would be regarded as adequate authority for saying what coupler will save the most lives and be the least dangerous? How should dead-blocks, ladders, steps, running boards, "grab-handles," etc., be arranged so as to give the greatest protection to life and limb? With the multiplicity of methods of heating and lighting cars, which one should be used? and as those arts are still in the evolutionary stage, if one of them is the best now, will it continue to be the best? If the Interstate Commission undertake to say authoritatively which is the best, they will be obliged to establish a bureau of railroad engineering, and then the responsibility will be transferred from the railroad companies to the shoulders of the Commission.

The circular is addressed to the labor organizations of the country, and its general purport is an inquiry as to what ought to be done. Whether the Commission will get much information from the members of these organizations remains to be seen. As a general thing, laboring men seem to take very little interest in questions which relate to the security of life and limb in the occupations in which they are engaged.

A very full investigation of the question of legislation with reference to Railway Accidents was made by a Commission appointed by the British Parliament in 1874. This Commission made an elaborate report in 1877, which, with the evidence submitted, forms a volume of more than 1,200 pages. It is full of interesting and valuable information which would be profitable reading for railroad managers and railroad commissioners generally. It contains a great deal of testimony bearing upon the question of legislation for the prevention of railroad accidents. Some of the evidence was given by T. R. Farrer, Esq., Permanent Secretary of the Board of Trade, who, we believe, has since then been knighted, and by Captain, now Sir Henry Tyler, who for a long time was an inspecting officer of the Board of Trade, which in Great Britain exercises more or less control over the railroads of the kingdom. A considerable amount of inquiry was made by the Commission with reference to the advisability of enlarging the powers of the Board of Trade for the prevention of railway accidents. Quite naturally there was much difference of opinion among those who gave the testimony to the Commission. It may, however, be assumed that persons who have been engaged for years in the investigation of the subjects to be legislated on would know more about them than any one else. The fact that the gentlemen named had occupied such prominent positions on the Board of Trade gives their testimony especial value, and also more weight than that of any other witnesses could have. It might also be expected that the members of a board of this kind would naturally seek for an extension of their authority, as a lust for power is usually a besetting vice of officials

of all classes. This estimate of the value of their testimony is, however, confirmed by the fact that both the witnesses named were strongly opposed to any, or, at least, favored very little extension of the power of the Board. Their testimony with reference to the limits of Government interference with railroad companies may, therefore, be accepted with more confidence than it could be if those who gave it sought an extension of their authority and privileges.

In a "memorandum" on the expediency of creating additional powers for the prevention of railway accidents, after referring to the fact that some companies had not readily adopted improvements in railway construction, Captain Tyler said:

At the same time it is to be observed that during the past five years such improvements have made much more rapid progress than during any previous period of railway history. The series of annual general reports on accidents, in which all the causes have been minutely analyzed, and all the remedies carefully set forth, has been mainly instrumental in producing this effect. The weak points on various railway systems have thus been demonstrated. . . .

If only the same process be continued, the same care be taken, and the recommendations found necessary be persistently and publicly made in the same way from year to year, similar beneficial effects may be expected to accrue in future years with constantly accumulating force; and the railway system of this country will attain generally a very high degree of efficiency in all respects, including matters appertaining to public safety.

The companies have in this way been induced, under the stimulus of official recommendation, backed by well-informed public opinion, themselves to carry out improvements in construction, appliances, or working, in the success of which they were mainly interested. They have satisfied themselves of their utility before adopting them, and have employed them on their own responsibility. They would not have the same interest in the successful working of improvements forced upon them under the orders of a tribunal, and many other disadvantages would be experienced in the application of any other form of direct compulsion. The companies would be partially relieved from their responsibilities, further invention and improvement would to some extent be discouraged, and undue responsibility would inevitably be thrown upon the tribunal. So long as railways are in the hands of companies, working for a profit, they must be managed by the officers of those companies. The directors and officers being directly exposed to the influence of public criticism, a more powerful effect may thus be produced on them than that which they feel from any pecuniary obligations which they may or may not incur in cases of accident. But if, in working their various systems, under different conditions and in different localities, they were subject to the direct instructions of a general tribunal, they would then be able to plead in the event of an accident that they had not been called upon to provide the means by which it might have been avoided. The responsibility might thus be thrown back upon the tribunal, and public opinion would be diverted, with the eager assistance of the legal advisers and officers of the companies, toward the proceedings of the tribunal, which would be ill able to defend itself, and would be exposed from time to time to the obloquy of not having been sufficiently active in requiring improvements in various parts of the country, by means of which serious accidents might have been avoided. The tribunal, helpless as to any control over the actual working of the railways or the discipline maintained among the servants of the companies, would, when thus attacked, become, in self-defense, more and more exacting, and its tendency would be to err in the extreme of excessive interference. Its end would be ignominious, under a joint and hostile outcry from the companies and the public. It would be accused at once of meddling mischievously and of not interfering sufficiently, and would fall under the imputation of inefficiency and want of judgment as accidents occurred to afford, rightly or wrongly, opportunities for angry criticism. Questions of compensation to injured passengers would also be materially complicated, as blame was bandied backward and forward between the tribunal and the companies.

There would, of course, be the greatest difficulty in determining the amount of interference which such a tribunal should exercise. There are many well-recognized requirements; if the tribunal had power to enforce any of them, it should enforce them all. It would be almost impossible to draw a line. On

the discovery of any new means of safety, real or supposed, the tribunal would have power to enforce its adoption. If it should turn out to be less successful in practice than was expected, or if it should in some unforeseen way lead to mischievous results, the position of the tribunal would not be improved, and an outcry at one time for the universal adoption of some particular improvement might be succeeded by another outcry at some other time for its abolition, or for some other improvement in place of it.

Looking to the history of the past five, ten, and twenty years, respectively, it will be seen that improvement, which has been more or less gradually progressive, has also advanced more rapidly within the shorter periods, and it may be taken for granted that further improvement will continue to be made in almost every branch of railway construction and apparatus. While recommendations, as at present made, may be general, and may deal with principles, any attempt to compel companies to adopt them would necessarily deal with specific apparatus. The requirements enforced by any tribunal would, therefore, be specific, and the tribunal would be obliged to prescribe the particular appliance and apparatus to be adopted, or, in other words, to decide between competing inventors on the respective merits of their inventions. What was considered to be the best at a particular period would be insisted on for application on all railway systems, and its general adoption would tend to act as a bar to future improvement.

In giving his testimony, Mr. Farrier, the Secretary of the Board of Trade, submitted in writing a short outline—which he said he had prepared carefully—of what had occurred to him on the subject of the limits of Government interference with railway companies, from which the following extracts are made.

1. The railway companies have no right to object to any interference requisite for securing the public safety. They have a monopoly of public traffic, and are bound to do whatever is necessary for that object.

2. Nor is it necessary to argue that railway administration is perfect. It may be admitted that though their business is in general well and ably conducted, they are sometimes poor, sometimes niggardly, sometimes slow, and sometimes obstinate. Railway companies have also some of the defects of public departments in the size and cumbrous character of their official machinery, and in the remoteness of the bearing of the important motive of self-interest on the directors and managing officers. . . .

5. But after all these admissions, general interference with the administration of railways is objectionable on the following grounds:

6. By such interference you are setting two people to do the work of one. Double management is notoriously inefficient. One bad general is better than two good ones.

7. You set those who have less experience of management and less personal interest in the result to control those who have more.

8. Control is either apt to become formal and a sham, or if zealously and honestly exercised, to be rigid, embarrassing, and a hindrance to improvement.

9. Many excellent things, the adoption of which is desirable for public safety—e.g., the block system, interlocking points and signals, efficient brakes, properly constructed tires, are not things which can be once for all settled, defined and prescribed, but things of gradual growth, invention and improvement. Had any of these been prescribed by law at any past time they would probably not have been what they are now, and were they now prescribed and defined by law future improvement would be checked. This is a most insidious form of evil, for we do not know the good which we thus prevent. It is no answer to say that Government control would be intelligent, and would encourage improvement. It is not Government or its officers who invent or adopt inventions, and those who do so are far less likely to improve when Parliament or Government has defined and prescribed a definite course, the adoption of which frees them from responsibility. . . .

12. Lastly, it is impossible to maintain at the same time any general system of Government control, and any effectual responsibility on the part of the companies. At present the companies are responsible to public opinion and to Parliament, before which they have constantly to appear, and they are under heavy liabilities for accident and danger in courts of law. Once admit Government control and these liabilities are at end. No one can find fault with a company for that which the Government has sanctioned. With a system of control, even Government inquiry will be useless, for the Government officers would be inquiring into their own acts. . . .

15. It is scarcely necessary to add that the reasons against Government control which are above advocated are entirely consistent with a thorough system of Government inspection and investigation. The function of throwing light on all parts of the railway system; of investigating all alleged dangers, whether accidents have happened or not, and of ascertaining the true cause of accidents which do happen, is one which the Government can exercise with the utmost possible advantage and without fear of dangerous results. It is one which is useful to the companies; for it points out to them real sources of danger, and relieves the public mind where there is unfounded apprehension of danger. It brings to bear on the companies the powerful motives of fear of public opinion, of Parliamentary pressure, of apprehension of loss of traffic, and of legal liability for damages. And it does this without ulterior ill consequences. It is because these forms of remedy are in reality of very great efficacy, and because they are inconsistent with Government control, that I deprecate the latter.

The Board of Trade, the Secretary said, had relied more upon publicity than upon any legislative action, and as he took occasion to say further, "they have thought that whereas it was not expedient as a general thing to interfere with the working or management of railways, it was the business of the Government to throw light upon everything which occurred on railways and upon the causes of accidents."

But, it may be asked, supposing that the Interstate Commission should have authority delegated to investigate and report on accidents, and the railroad companies inertly do nothing toward adopting appliances and precautionary means to prevent accidents, should not Congress adopt compulsory measures? It is not well to anticipate too much. When compulsion is needed, the necessity will make itself apparent. The Interstate Commission can occupy itself very profitably for the present in showing where compulsion is needed, and when this is made clear, Congress will not be slow in exercising its authority. The Commission asks what should legislation attempt to accomplish in regard to couplers; in regard to train-brakes; in regard to car heating and lighting, and in regard to other matters.

The trouble here lies in knowing just what ought to be done. There ought not to be much difficulty in having a law passed compelling railroad companies to use a certain kind of coupler, if it could be made clear to Congress that its general adoption would be instrumental in saving lives and limbs, without incurring other equally or more serious evils. Here is where the difficulty comes in. The Interstate Commission ought not to advise nor Congress compel the adoption of automatic couplers or steam heating for cars, nor continuous brakes for freight trains, without knowing that it is practicable to use them, and that the ends sought will be accomplished thereby. To illustrate the danger which lies in this direction, it may be said that only a few years ago, when the adoption of automatic couplers was made compulsory by legislation, one Company adopted a form of coupler and applied it extensively to its cars, which afterward proved to be a complete failure. The Company wasted many thousands of dollars, and no good was accomplished. The managers of the line referred to, after investigating the matter, made the mistake of recommending the coupler which was adopted. The Interstate Commerce Commission would probably be no less liable to make mistakes of this kind, which, if enforced over the whole country, would be very serious. The Commission may profitably lay to heart the advice of the elder Crockett, "Be sure you are right before you go ahead." The work of the Commission in securing the adoption of safety appliances must for a considerable time be tentative, and its recommenda-

tions must be confirmed by abundant experience. They ought to have full power to make investigations into the causes of accidents, and make these causes public, and for the present such powers would be their strongest weapons, which they could wield with little danger to themselves but with much benefit to the public, and without seriously antagonizing the great power and the influence of the railroad companies against their beneficent work. The time may come when compulsory legislation may be demanded, but there is great danger in the exercise of such power. To give authority to enforce the adoption of safety appliances would, in the present state of our civil service, almost certainly lead to corruption. Such power would be an invitation to bribery, and many of the promoters of patented devices would be only too ready to blind the eyes and pervert the judgments of any or all who could exercise it.

There are some precautions for the safety of railroad employés, such as a maximum and minimum height of draw-bar, a standard form of wheel tread and flange and width of gauge of wheel, the form, proportions and height of dead-blocks, and a minimum clear space between cars when the dead-blocks are in contact, which certainly should be generally adopted; but a distinct recommendation of these, and the fact that the neglect to act upon such a recommendation would incur more or less legal responsibility for injuries to employés, would for the present, at least, be authority enough. To compel all the railroad companies of the country to adopt some system of steam heating for cars, continuous freight car brakes, automatic couplers, and improved signals would involve the expenditure of many millions of dollars, and would bankrupt some of the weaker lines. The consequence would be, if it had the power to compel the adoption of such appliances, that pressure would constantly be brought to bear on the Commission to recommend only such as the poorer roads could afford to put on.

A system of inspection which would take cognizance of over a million of cars and some 28,000 locomotives is a colossal undertaking, and in the shadow of some of the scandals which are whispered and spoken with more or less distinctness concerning the steamboat inspection service, it would seem to be a dangerous undertaking.

There are the precedents of the working of the Board of Trade of Great Britain and of some of our own State Railroad Commissions, to show how successful such agencies may be when entrusted with little other power than that of investigation and recommendation, and with the duty imposed on it of making public the evils that they discover. In the light of such experience, and in the shadow cast by public corruption, civil service inefficiency, and the prevalent malaria of selfish interests, it would seem unwise to give to any "special administrative agencies" any other power to interfere with railroad companies for the purpose of lessening the number of accidents than that of investigating and reporting on such accidents and safety appliances, with authority to recommend such as are approved.

If report speaks truly, the Interstate Commerce Commission is now overloaded, so that if any other investigations are to be made, the duty must be laid upon some other shoulders. If the investigation of railroad accidents and their causes and the efficiency of safety appliances is undertaken by the Commission, it must be done by an additional bureau; and if in addition it is to suggest what appliances should be used to prevent accidents, the personnel

of the new department should consist of technical experts. It seems as though it would be practicable to create an administrative body of this kind as an auxiliary to the present Commission, just as the Bureau of Steam Engineering and of Construction form part of the administrative mechanism of the Navy Department. An expert is placed at the head of each of these bureaus, with the requisite assistants to aid him. These departments are doubtless very much more efficient under one head than they would be if they were multicapital.

In response to the Commission's circular, our suggestion then is, that a bureau of mechanical construction and operation should be created as an auxiliary to the present Commission, and with a technical expert at its head and three assistants to correspond to the inspectors of the British Board of Trade. This bureau to have authority to investigate and report on railroad accidents, to test safety appliances, and recommend to the Commission such legislation as the investigations of the bureau may suggest is needed. This is as far as it would seem wise to go at present.

LONG LOCOMOTIVE RUNS.

In the article on the Strong locomotive, in the May number of the JOURNAL, it was stated that the run which the Strong engine made from Jersey City to Buffalo on the Erie Railroad was the longest continuous run of which we have any record, with the exception of a trip from Jersey City to Pittsburgh on the Pennsylvania Railroad some years ago. This statement, which was made from memory and without investigating the records, was, it appears, erroneous. The train, which was famous at the time as the "Jarrett & Palmer Fast Train," and which ran from Jersey City to San Francisco in 84 hours, was drawn over the Central Pacific Railroad from Ogden to Oakland, 879 miles, by a single locomotive, which, like the Strong locomotive, made stops at several points. Memory as to this run is refreshed by several correspondents, and the particulars were as follows: From Ogden westward over the Salt Lake Division, 182.7 miles, the average speed was 44.56 miles an hour; over the Humboldt Division, 236.5 miles, the average speed was 43.55 miles; on the Truckee Division, 204.5 miles, the average speed was 42.16 miles; on the Sacramento Division, 119.5 miles, the average speed was 31.28 miles, and on the Western Division, 136 miles, average speed, 42.06 miles. The greatest speed attained at any point on the journey was 60 miles an hour; the average speed for the whole distance, 36.8 miles an hour.

The engine which made this very unusual run was an ordinary eight-wheel engine, No. 149, built by the Schenectady Locomotive Works, having 16 by 24-in. cylinders and 5-ft. drivers. The weight of the engine was 65,450 lbs.; the tank capacity was 3,700 gallons. Only the necessary stops were made—the number of them we have not at hand—and the full time was 23 hours, 59 minutes.

As before noted, while neither this run nor the run of the Strong locomotive were continuous in a certain sense, both of the engines having made stops at several points, the run made from Jersey City to Pittsburgh on the Pennsylvania Railroad was really *continuous*, the engine having gone over the entire distance without stopping, water being taken up from the track-tanks on the way.

This, of course, does not detract from the work done by the Strong engine; it only shows that such runs *can* be made on occasion, but their rarity goes to prove that the making them is too much for the ordinary locomotive.

NEW PUBLICATIONS.

REPORTS OF RESEARCHES CONCERNING THE DESIGN AND CONSTRUCTION OF HIGH MASONRY DAMS, IN VIEW OF THE PROPOSED BUILDING OF THE QUAKER BRIDGE DAM. New York; published by the Aqueduct Commission, New York City.

Probably no single engineering structure in this country has called out more discussion or more elaborate investigation than the Quaker Bridge Dam, which is to complete the works for increasing the water-supply of the city of New York. The discussion in the first place was over the question as to whether the dam should be built or not, and when that was virtually decided a still more active discussion sprung up as to how and just where it should be built. This was natural enough when we consider that the dam will be the largest, or at any rate the highest in the world, and will take its rank among the great engineering works of America.

The Aqueduct Commission has done well in preparing and issuing the handsome book before us, and in thus putting into a form accessible to the engineering public the elaborate reports which have been made on the subject. These consist in the first place of the report by Mr. B. S. Church, Chief Engineer of the Aqueduct; then the report of Mr. A. Fteley, the Consulting Engineer, and finally the report on the plan and location of the dam made by the Board of Experts, who were called in by the Commission, these experts being Messrs. Joseph P. Davis, James J. R. Croes, and William F. Shunk. These reports are published in full; the book includes not only the text of the reports, but the elaborate tables and calculations which accompany them, and engravings of the diagrams submitted. The report thus becomes practically a treatise upon high masonry dams, for the engravings include not only plans and elevations on the Quaker Bridge Dam, but also sections of nearly all the important structures of the kind in America and Europe, which were used for purposes of illustration and comparison.

THE JOHNSON RAILROAD SIGNAL COMPANY'S CATALOGUE OF INTERLOCKING AND RAILROAD SIGNALING APPLIANCES. Rahway, N. J.; issued by the Company.

This is a very neat and convenient book of 140 pages, 8 in. x 10 in. in size, which is well printed on good paper, and with excellent engravings illustrating the mechanism manufactured by the Johnson Railroad Signal Company. It begins with a brief history of the introduction of interlocking signals in this country, and a statement of the advantages resulting from the use of such appliances. These are said to be increased safety and increased facility in handling traffic at busy points. This is supplemented with a dissertation on the essentials of good signaling, which every railroad engineer and traffic manager would do well to read, and for that reason it is quoted almost entire:

The experience of 25 years has pretty conclusively shown among other things that the Semaphore Signal is the most satisfactory type of signal; that switches and locks should be worked by pipe; that facing switches should be fitted with facing-point locks; that facing-point locks should be duplex—i.e., so arranged that in the event of the breakage of connection, the plunger of the lock cannot be thrown into the wrong position of the switch; that two lines of wire should be used to each signal; that signal blades should be so constructed as to go to the danger position in case of breakage of connections anywhere between the operating lever and blade; that wires to distant signals should be automatically compensated; that iron plates

should be fixed under switch points to keep the track accurately to gauge; that plungers of facing-point locks should not be pointed; that cranks and pipe compensators should be fixed on foundations firmly embedded in concrete; that all side tracks connected to main tracks should be "trapped"—i.e., have a derailing switch to prevent cars coming on to the main track, until the switch is set for the side track; that a signal should be given for every train movement; that high signals should only be used for main running tracks; that separate signal-posts should be used for each track running parallel or converging; that one post with one or more blades (various systems are in use for indicating the route open) should be used for diverging tracks; that it is a most dangerous and reprehensible practice to displace or disconnect any part of safety appliances, such as detector-bar, switches, switch-locks, machine, interlocking, except in cases of absolute necessity, and then only temporarily and under proper protective conditions, such as padlocking the switches affected, issuance of caution notice, and employment of flagmen at the positions of danger; that all ground connections should be well drained and all the appliances kept clean.

This summary of good signaling requirements is followed by short notices of various inventions which have been brought out, some of which have and some have not been successful. "General instructions for operators and for the maintenance and repair of interlocking machines and work in connection therewith" are also given, with a short article on block signaling. The rest of the work is devoted to a description of the special appliances which are manufactured by the Johnson Railroad Signal Company, with complete and detail engravings of different appliances. The book is very neat, the work of printing and engravings is excellent and in good taste, and there is an entire absence of the "gay and festive" appearance which is sometimes so nauseating in a business catalogue. Railroad managers and engineers will find it difficult to pick up so much valuable information about the essentials of signaling from any other source, and in so short a time as they would be able to absorb by reading the first dozen pages of this volume, and looking over the rest of it with more or less care.

The works of this Company are at Rahway, N. J., and the New York office is at No. 146 Broadway.

THE RAPID TRANSIT CABLE COMPANY'S CABLE TRACTION SYSTEM. New York; issued by the Company.

The pamphlet before us is an illustration of the fact that much of the best technical literature now appears in trade catalogues. Many improvements in engineering and discoveries and inventions in science are never described anywhere else than in such publications. The volume before us contains a description and illustrations of the system of cable traction, which is covered by patents controlled by the Company named, and also gives comparisons of the relative merits of that kind of motive power for rapid transit roads compared with other means of propulsion. It is a pamphlet of 81 pages, and contains elaborate engravings of the structures and appliances referred to in the text. The office of the Company is at 12 Broadway, New York.

ABOUT BOOKS AND PERIODICALS.

IN accordance with the expressed wish of the late Captain John Ericsson, his biography will be written by his intimate friend, Colonel W. S. Church, Editor of the *Army and Navy Journal*. Captain Ericsson's executors have placed in Colonel Church's charge all his papers and documents which may be of use for this purpose.

A paper on the Rio San Juan de Nicaragua, by Civil Engineer R. E. Peary, U.S.N., which is published in the last number of the *BULLETIN* of the American Geographical Society, is a

careful description of that stream, which is to play so important a part in the construction of the Inter-oceanic Ship Canal, with some historical account of the part it has in previous times taken in the commerce of the world.

The May number of the *JOURNAL of the Military Service Institution* contains articles on a Mission for the Infantry Service, by Brevet Major-General A. V. Kautz; on Horse-Shoeing, by Major George B. Rodney; on the Practical Training of Field Batteries, by Lieutenant C. B. Satterlee, and a comparative table of the Relative Values of Field Artillery Guns, by Lieutenant A. D. Schenck. There are also a number of short articles from foreign sources, including a continuation of the very interesting letters of the different branches of the service, by the Prince Hohenlohe-Ingelfingen. The shorter notes and reviews touch on many points of interest, including the National Reserve, the Cavalry Service, Coast Defense, etc.

Among the articles in the *OVERLAND MONTHLY*, for May, are some Studies on Conciliation in the Labor Problem, an interesting contribution to the already voluminous literature on this subject; an account of the Oregon Indian Campaign of 1884, given under the guise of a story; while *Life in Samoa*, by S. S. Boynton, is a contribution to our knowledge of that little island, with which we will soon be better acquainted, by description at any rate, than with a good many portions of our own country.

The series of Railroad articles in *SCRIBNER'S MAGAZINE* is not yet completed. One on Safety Appliances, by Colonel H. G. Prout, and one on the Purchasing and Supply Department, by Mr. Benjamin Norton, an officer of long experience in that department, are still to appear. The June number will contain the first of the proposed series of articles on the Practical Application of Electricity. These articles will be written by experts, and are intended to give a complete statement of the present condition of Electrical Science in relation to industrial and practical life.

In the *POPULAR SCIENCE MONTHLY* for May, Professor C. Henderson Hall gives the second of an interesting series of articles on Glass-Making, which has special reference to that industry as carried on in Pittsburgh. Mr. Garret P. Serviss contributes an article on the Strange Markings on Mars, which are supposed to be the visible phenomena which indicate that that planet may be inhabited, and which, some astronomers have imagined, show the existence of gigantic engineering works on its surface. Among the articles in the June number will be one on the Production of Beet Sugar and also one on the Glaciers on the Pacific Coast, a subject of much interest to geologists.

In *HARPER'S MAGAZINE* for May, Franklin Satterthwaite writes of the effect which railroad extension and its results have had upon the wild game of the western plains and the Rocky Mountains, and of the future prospects for sportsmen in that region.

Samoa is the text for two articles in the *CENTURY* for May, which describe very completely that distant corner of the earth, which has been brought into prominence recently by the little international flurry of which it has been the cause. The descriptions are interesting reading. In his Siberian article, in the same number, Mr. Kennan writes with his usual force of the Trans-Baikal, to us an almost unknown region, which will become of commercial importance when the Siberian Pacific Railroad is built, since it has considerable possibilities of development, and, moreover, has on its southern border the twin cities of Khabkta and Maimachin, through which passes the large overland commerce between Russia and China.

The *ECLECTIC MAGAZINE* for this month contains the usual well-selected miscellany from the foreign magazines, which is especially interesting to those who have not the facilities for reading the originals, but who desire to keep in touch with the foreign magazine literature of the day.

BOOKS RECEIVED.

A HISTORY OF THE PLANING MILL, WITH PRACTICAL SUGGESTIONS FOR THE CONSTRUCTION, CARE AND MANAGEMENT OF WOOD-WORKING MACHINERY: BY C. R. TOMPKINS, M.E. New York; John Wiley & Sons, 15 Astor Place.

SEVENTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY TO THE SECRETARY OF THE INTERIOR, 1885-86: BY J. W. POWELL, DIRECTOR. Washington, Government Printing Office.

A THEORETICAL AND PRACTICAL TREATISE ON THE STRENGTH OF BEAMS AND COLUMNS: BY ROBERT H. COUSINS, C.E., LATE ASSISTANT PROFESSOR OF MATHEMATICS AT THE VIRGINIA MILITARY INSTITUTE. New York and London; E. & F. N. Spon.

IMPROVEMENTS IN THE CONSTRUCTION OF VARIOUS TYPES OF RAILROAD CARS: BY MAX A. ZURCHER. Montreal, Canada; published by the Author.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1888. ELEVENTH NUMBER: PREPARED BY THE BUREAU OF STATISTICS, UNDER THE DIRECTION OF THE SECRETARY OF THE TREASURY. Washington; Government Printing Office. The present number contains statistics of finance, coinage, commerce, immigration, shipping, postal service, population, railroads, agriculture, etc.

RELATIVE COST OF CARLOAD AND LESS THAN CARLOAD SHIPMENTS AND ITS BEARING UPON FREIGHT CLASSIFICATION: BY ALBERT FINK. Chicago; published by the *Railway Review*. This is a reprint of a part of the argument prepared by Commissioner Fink and submitted to the Interstate Commerce Commission, on behalf of the defendant trunk lines in the case of the complaint of Thurber and others.

THE SECURITY OF RAILWAY INVESTMENTS: BY DANIEL S. REMSEN. New York; reprinted from the proceedings of the Twelfth Annual Meeting of the New York State Bar Association.

REVISTA TECNOLÓGICO INDUSTRIAL: NOS. 7 & 8, FEBRERO, 1889. Barcelona, Spain; published by the Association of Engineers.

ANALES DE LA SOCIEDAD CIENTÍFICA ARGENTINA: NO. VI., 1888, and NO. I., 1889. Buenos Ayres; published by the Argentine Scientific Society.

BULLETIN OF THE AGRICULTURAL EXPERIMENT STATION, CORNELL UNIVERSITY, COLLEGE OF AGRICULTURE: V., APRIL, 1889. Ithaca, N. Y.; published by the University.

CABLE TRACTION SYSTEMS OF THE RAPID TRANSIT CABLE COMPANY, NEW YORK. New York; issued by the Company, Cornelius Tiers, President, John H. Pendleton, Engineer.

CENTRAL EXPERIMENTAL FARM: BULLETIN NO. 4, MARCH, 1889. Ottawa, Canada; issued by the Department of Agriculture.

SIXTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK, FOR THE FISCAL YEAR ENDING SEPTEMBER 30, 1888: WILLIAM E. ROGERS, ISAAC V. BAKER, JR., MICHAEL RICKARD, COMMISSIONERS. Albany, N. Y., State Printers.

PROCEEDINGS OF THE FIFTH ANNUAL MEETING OF THE IOWA SURVEYORS' ASSOCIATION; THE FIFTH ANNUAL MEETING OF THE IOWA CIVIL ENGINEERS' SOCIETY; AND THE ORGANIZATION OF THE IOWA SOCIETY OF CIVIL ENGINEERS AND SURVEYORS: JANUARY, 1889. Glenwood, Iowa; issued by the Society. Seth Dean, Secretary.

THIRD ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF BUILDERS OF THE UNITED STATES; HELD AT PHILADELPHIA, FEBRUARY 12-14, 1889. Boston, Mass.; issued by the Association. Mr. William H. Sayward, Secretary.

CATALOGUES AND PRICE LISTS OF THE BROWN & SHARPE MANUFACTURING COMPANY; ALSO OF DARLING, BROWN & SHARPE. Providence, R. I.; issued by the Company. The reputation of these manufacturers for machine tools and also for rules, gauges, and other instruments for accurate measurement is well known.

COUNTERBALANCING LOCOMOTIVES.

To the Editor of the Railroad and Engineering Journal:

THE following article appeared in the *Railroad Gazette* of April 12 last:

Within the last year, on five different occasions, it has come to our knowledge that locomotives running at high speeds have severely injured the rails and track of five different roads. This was the result, not in every case of over-counterbalance, but rather of the attempt to counterbalance the inertia, in a horizontal direction, of the reciprocating parts. These actual facts take the action of locomotive counterbalances on rails and bridges out of the field of mere speculation. To show what may be the effect of these counterbalances at high speeds, we may state that in two cases of the five just mentioned the rails were bent vertically to such an extent as to render the track impassable at high speeds for over two miles in length, and in one case the wheel rose so far from the track in its upward gyration as to crush the wheel-guard and running-board. We have called attention to the necessity for giving much care to this subject before in these columns, and we wish to again urge all engineers who are interested in this subject, either from choice or because of their responsible connection with railroad corporations, to offer something, either in the way of design or suggestion, which will reduce the evil which already exists in the best designs, and allow locomotives to be driven at the high speeds of the immediate future without endangering the permanent way. We are not offering this as a result of speculation, hypothesis or incomplete theory, but rather as facts which are so obstinate and pertinent that two railroad companies have decided to order the removal of all that portion of the counterbalance in locomotive driving-wheels which is intended to counteract the inertia of the reciprocating parts. In order to assist in obtaining information for certain engineers of the highest standing, we propound the following question to our readers, with the hope that they will consider it a personal inquiry, directed particularly to themselves, and, as such, give it their best attention. Is it necessary to add to a locomotive driving-wheel counterbalance an additional weight to resist the inertia of the reciprocating parts, and thereby reduce the motions of a locomotive known as nosing, lurching, and galloping?

After much study, practice and consideration I am firmly of the opinion that it is, in the face of the facts produced that the rails were damaged in two cases out of five, so as to be unsafe at high speeds. Does this prove that it is unnecessary to counterbalance the reciprocating parts?

No! It only proves that at *high speeds* mentioned these engines over-counterbalanced. It is not stated that at slower speeds they were properly counterbalanced, but assuming that they were correct for a speed of 30 miles per hour, and over-counterbalanced for 60 miles per hour, is it any reason why we should throw away the balance for the reciprocating parts?

Before doing that, knowing the trouble it would produce, would it not be well to investigate the cause for the difference (as it surely exists) between the amount of balance required for slow and high speeds? I would say, Yes, and look for natural causes. I have been aware for a long time that such discrepancy existed, and have tried some practical experiments to discover why it was, as it seemed unnatural that it should be so.

Take, for example, 550 lbs. of reciprocating parts (on each side) on a locomotive making 336 revolutions per minute (which would be about 60 miles an hour for a 5-ft. wheel). Does it not seem ridiculous for any one to propose to bring this heavy weight from a rapid movement to a state of rest 672 times per minute without any help?

Reciprocating parts must be counterbalanced to insure safety, and *speed* is one of the most important factors in the problem, as with increased speed all relations between the propelling and resisting forces in the cylinder are greatly changed—the propelling forces being reduced while the resisting forces are increased (this, of course, refers to

the link-motion engine and not to one having a constant lead, exhaust opening and closure).

No one will, I think, question that the resisting forces (back-pressure, compression and lead) are prime factors in counterbalancing an engine properly.

If this is true, is there any difficult question as to the discrepancy between a locomotive counterbalance for 30 miles or 60 miles per hour?

We design an engine for speeds of from 25 to 40 miles per hour. In doing this we aim to so proportion our ports, and the time these ports are open, as to give perfect release to escaping steam, and thereby avoid any back-pressure from this cause, until exhaust closure takes place and compression commences.

We do this correctly for speeds of about 30 miles per hour, and no fault is found with the riding of the engine; but after a time she is put on a fast train and at once reports reach you about the jumping of the engine, especially if you have any weak or springy bridges, or a portion of track that is spongy.

This is proof conclusive that the engine is over-counterbalanced for the high speed, but not for the slower ones. No alteration is made in counterbalance, but the resisting forces in the cylinder are greatly increased; the port and time are not adequate to release the escaping steam, and the back-pressure runs up from zero to say from 4 to 10 lbs. previous to the commencement of compression, which starts in with this increased pressure; this, of course, increases your resisting forces, which is equivalent to adding counterbalance, and produces the same effect as decreasing the reciprocating parts—or, in other words, makes the engine over-counterbalanced for the high rate of speed.

PREVENTION OF RAILROAD ACCIDENTS.

THE following circular has been issued by the Interstate Commerce Commission, under date of May 17, addressed to all State railroad commissions and to some others who are supposed to have given especial attention to the matters involved:

The large number of accidents to employes and passengers occurring on the railroads of this country and the public belief that a great part of these might be avoided by the use of proper appliances have led many States to make the mechanical features of railroad working the subject of statutory regulation. It is well known, however, that in respect to some at least of these features, the conditions are such that regulation if attempted can neither secure adequate benefit to the public nor be just to the railroads themselves unless it be uniform over the whole country.

In view of this fact and of the request of the Railroad Commissioners of the country, as embodied in a resolution adopted at their recent convention, the Interstate Commerce Commission desires to call out as full information and discussion as possible upon the question of Federal regulation of safety appliances on railroads. The following matters seem to be of especial importance, but it is not intended to restrict the discussion to them:

1. The history in each State of safety-appliance legislation. How far such legislation has been enforced. What have been the means used to enforce it. What obstacles have been met with. What the general effect has been.
2. What is the present condition regarding automatic couplers. What prospect there is of a uniform and safe coupler coming into use. What progress the standard coupler, adopted by the Master Car-Builders' Association, is making, and what is the attitude of railroads toward it.
3. What progress there is in the use of train-brakes on freight cars. Whether such progress is satisfactory, viewed as a means of greater safety to train men. To what extent freight trains are run without the necessity of brakemen traversing the tops of cars.
4. What is being done to introduce safer methods of heating and lighting passenger cars.
5. What is the state of affairs respecting other safety devices.

6. Whether legislation looking to Federal regulation of these matters or any of them is desirable, and what the reasons are for and against such regulation.

7. What such Federal legislation, if any be desirable, should attempt to accomplish in regard to couplers; in regard to train-brakes; in regard to car heating and lighting; in regard to other matters. What its provisions should be upon each of these points.

8. If Federal legislation be expedient, what special administrative agencies, if any, should be provided to carry it out. Whether Federal inspection should be attempted, and to what extent and how. Whether a Board should be created after the analogy of the Steamboat Inspection Service. If so, how such a Board should be constituted in regard to the number and character of its members; what its powers and duties should be; what its connection with other branches of administration.

The Commission believe that justice to railroad employes and to all others concerned requires that this matter receive thorough consideration, and trusts that you will be able to give it immediate and careful attention.

UNITED STATES NAVAL PROGRESS.

THE plans and specifications of the three 2,000-ton steel cruisers authorized by the last Congress have all been completed at the Navy Department. These vessels are at present officially known as Cruisers Nos. 9, 10 and 11. The limit of cost is fixed at \$700,000 each. The plans are the work of the bureaus of the Navy Department, and if all expectations are realized these vessels will be the best of their class afloat.

They are to be 300 tons larger than the *Yorktown* and her class. The principal dimensions are as follows: Length on load water-line, 257 ft.; extreme breadth, 37 ft.; depth of hold to under side of spar-deck amidships, 19 ft. 6 in.; mean normal draft, 14 ft. 6 in.; displacement to load water-line, 2,000 tons; tons per inch at load water-line, 15½; area of immersed midship section, 665 sq. ft.; transverse metacenter, 7 ft. above center of gravity. These vessels are to be twin-screw, protected cruisers with poop and fore-castle decks and open-gun decks between, fitted with water-tight decks of 17½ lbs. plating at sides, reduced to 12 lbs. in the center, extending the entire length of the vessels. This deck is to be below the water-line at the sides 36 in., and all the machinery, magazines, and steering apparatus are to be below it. The rig is to be that of a two-masted schooner, bearing a small spread of canvas. The motive power for each vessel is to be furnished by two triple-expansion engines of 5,400 H. P., with cylinders of 26½, 39, and 63 in. in diameter and 33 in. stroke. The engines and boilers are to be placed in separate water-tight compartments. The crank-shafts are to be made interchangeable. All framing, bed-plates, pistons, etc., are to be of cast steel. The boilers are to be five in number, made of steel, and designed for a working pressure of 160 lbs. They are to be of the return-flue tubular type. Three are to be double-ended and two single-ended. The latter are to be used as auxiliaries, but when steaming full power they can be connected with the main engines. The vessels are to attain a speed of 18 knots under forced draft. The normal coal supply will be 200 tons, with a bunker capacity of 435 tons. The coal will be stored so as to give all possible protection to the ship.

The entire main batteries are to be composed of rapid-fire guns as follows: Two 6-in. rapid-fire breech-loading rifles, mounted on fore-castle and poop decks, and eight 4-in. rapid-fire breech-loading rifles, mounted four on each broadside. The secondary batteries are each to contain two six-pounder rapid-fire guns, two three-pounder rapid-fire guns, two revolving cannons, and one Gatling gun. The torpedo outfit of each vessel will be six torpedo tubes for launching automobile torpedoes, one each at the stem and stern and two on each side. There will be a complete outfit of boat spar-torpedo gear and charges. A conning-tower, oval in shape, is to be located on the fore-castle deck, being 7½ ft. athwartships by 4 ft. fore and aft, and 5 ft. 4½ in. above the deck. It is to be fitted with steam steering-wheel, engine-room telegraphs and speaking-tubes. A wooden pilot or chart-house is to be fitted forward of the

conning-tower for ordinary use when not under fire. The ventilation, drainage, and electric-lighting systems are to be unusually good.

The berth accommodations and officers' quarters are to be greatly improved, and an innovation on previous arrangements made in the location of the steerage, which is to be aft of the wardroom, giving the senior officers quarters nearer amidships, which is freer from the jar of machinery and motion of the ship. Entrance to the steerage is to be effected through the after 6-in. gun supports, leaving an exclusive entrance to the wardroom for the officers quartered there, and at the same time giving spacious and more retired accommodations to the steerage.

It will be seen that these vessels are to develop 2,500 H. P. more than the *Yorktown* and nearly 500 more than the *Chicago*, with more than twice their displacement. Their speed is to be two knots faster than the *Yorktown*, equal to that of the *Charleston*, and within one knot as fast as the *Baltimore*, the *Philadelphia*, and the *San Francisco*, the great 19-knot cruisers in course of construction. The batteries of the new vessels, while not powerful enough to contend on equal terms with the great armor-clad battle-ships of other nations, could deliver a fire that would quickly sink any vessel not heavily armored, and, with their superior speed and manœuvring powers, they would be able to take every advantage of a slower opponent. The lines of the vessels and the disposition of their weights are such as to give them unusual stability.

The contract for the engines of the battle-ship *Texas* has been awarded to the Richmond Locomotive & Machine Works, Richmond, Va., the contract price being \$634,500. The *Texas* is being built at the Norfolk Navy Yard. There are to be two screws, each driven by a separate triple-expansion engine; each engine will have cylinders 36 in., 51 in., and 78 in. in diameter and 39 in. stroke.

TRIALS OF NEW VESSELS.

The new gunboat *Petrel*, built by the Columbian Iron Works, Baltimore, had a preliminary trial trip May 9, running down Chesapeake Bay and back. On this trial she worked very successfully, reaching a speed of 17 knots with 115 revolutions, and averaged 15 knots with 110 revolutions. The Government or official trial trip was to take place about June 1.

The official sea trial of the *Charleston* took place May 9, when she ran down the coast from San Francisco to Santa Barbara, and was continued for several days. The conditions were such as to give the new cruiser a very full trial, as she had to run against a head wind and through a very heavy sea. Her behavior at sea was excellent; her speed varied from 11 to 14½ knots, no effort being made to test her in this respect, as the trial was to prove her sea-going qualities mainly. On succeeding days she is said to have run up to 17 and 18½ knots. The official report has not yet been made public.

The dimensions of the *Charleston* have already been given, but may here be repeated as a matter of interest. They are: Length over all, 320 ft.; length on load line, 300 ft.; breadth, 46 ft.; main draft, 18 ft. 6 in.; displacement, 3,730 tons. She has twin screws with compound engines of the horizontal type, which are expected to work up to 5,000 H. P. with natural draft, and to 7,650 H. P. with forced draft. The maximum speed is expected to be 19 knots an hour. The armament will consist of two 8-in. and six 6-in. rifled cannons, and 12 smaller rapid-fire guns and two Gatling guns. The ship has been built by the Union Iron Works at San Francisco.

The Secretary of the Navy has extended for four months the time allowed the Union Iron Works to complete the large cruiser *San Francisco*, now under construction at those works.

TESTS AND EXPERIMENTS.

The Secretary of the Navy has appointed a Board of Engineers to make experiments and tests of tubular, sectional, and coil boilers, for the purpose of determining the best type for adoption. Chief Engineer Loring, formerly Chief of the Bureau of Steam Engineering, is at the head of this Board, and Chief Engineer L. J. Allen is Executive Officer. The experiments will be conducted at the New York Navy Yard.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

BY LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

(Continued from page 208.)

VII.—KRUPP'S SYSTEM.

PRUSSIA began rifled gun-making with cast-iron muzzle-loaders; experimented with breech-loaders of the same metal, and finally settled down upon Krupp steel (1861). In the earlier constructions the forgings were procured from Krupp and assembled at Government arsenals. After 1867 the finished guns were obtained from Krupp.

In the construction of his first guns Krupp employed a single block of hammered crucible steel. Increase in size of guns and higher powder pressures soon led to the adoption of the system of built-up guns, which, with some modifications as to details, is still followed.

A Krupp gun consists of two principal parts—an interior steel tube produced from a single ingot of hammered crucible cast steel, made cylindrical from the breech to a point in front of the trunnions, and conical from thence to the muzzle. Over the cylindrical part is shrunk the jacket, which carries the trunnions and contains the breech-block aperture, and upon this are shrunk two or three rows of bands or "frettes," made from solid disks of hammered steel. For large calibers the first row of bands extends to the muzzle.

The details of construction of the larger calibers of Krupp's guns are wanting. The cut (fig. 3) is given to show the general plan followed in their construction, with-

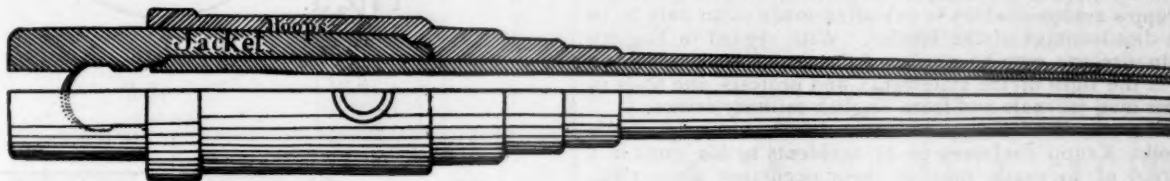


Fig. 3. Krupp Construction!

out attempting to give the details of the superimposed layers of hoops.

VIII.—SYSTEMS COMPARED.

In the early construction of heavy breech-loading ordnance by the English, the French, and the Germans, or Krupp, representing the three principal gun-makers of Europe, there was a wide difference both in the material used and the methods of construction. In guns of recent date, however, these differences have largely disappeared both as regards material and mode of fabrication.

In the matter of material steel alone is now used, the only question being as to the *kind* best adapted for gun construction. In the Krupp system, representing by far the largest output, as well as the ordnance of nearly all the lesser powers of Europe, crucible steel alone is employed. In England both crucible and open-hearth steel is used, with a leaning toward the latter. France uses open-hearth steel only.

In the methods of construction, or of assembling the different parts, there is no great difference. Shrinkage by heat is employed by all to bind the several parts together, except by Whitworth, who employs hydraulic pressure instead. Krupp has an inner tube of considerable thickness, a jacket and hoops; the French, a thick inner tube and hoops; the English, a comparatively thin inner tube, a thicker jacket and rings, or hoops, in two or three layers of varying lengths.

As will be seen by reference to the cuts, there is a very decided difference between the English system, on the one hand, and the French and Krupp on the other, as regards the thickness of the inner tube. In the former it is relatively thin, the superimposed hoops being depended upon to resist transverse rupture, while in the French system the tube forms practically the body of the gun. In Krupp's

system the tube is thick enough to do a fair share of the work of resisting transverse strains, and in thickness is medium between that used in English and French guns.

In the matter of ordnance England has been particularly unfortunate. Beginning with wrought iron and breech-loaders, then going back to the muzzle-loader, spending 20 years in elaborating a system of these guns, of wrought iron and steel combined, and finally casting aside old models, setting to work within the last eight years to fabricate a system of all-steel breech-loaders.

But from the beginning the same general principles of construction have been followed up to a very recent date. The defects of the system have been demonstrated by so many accidents and break-downs that the only wonder is that it was persisted in so long, remembering the vast metallurgical resources and experience in metal manipulation of the English nation. The matter has been explained, and perhaps justly, by the fact that the fabrication of ordnance has been practically in the hands of the Government, represented by the Royal Gun Factory at Woolwich, to which Armstrong seems to have been a half partner. Slow-going and blindly conservative, this military close corporation has stood in the way and so effectually discouraged all private enterprise that England, which should have taken the lead in the matter of gun fabrication, has had to take second, if not third place, to say nothing of the immense sums wasted upon muzzle-loading ordnance and wrought-iron vagaries.

So numerous had been the accidents to English guns that in February, 1887, the House of Commons directed that a report be made showing the number, etc., of rifled guns in the land and naval service that had burst or become disabled in the ten years between 1875-76 and

1885-86. The report, signed by Colonel Maitland, Superintendent of the Royal Gun Factory at Woolwich, under date of January 29, 1887, shows a total of 31 guns of various calibers as having been disabled within that period. Of this number 19 were Woolwich and 12 Armstrong guns; 12 also were breech-loaders and 19 muzzle-loaders. The breech-loaders were all Armstrong except two. Out of these 31 failures, 23 were reported as having occurred to the inner tube either by cracking at various points or, as in the well-known *Collingwood* gun accident, by its being blown away entirely. It should be said, however, that but one of these guns burst explosively. This was a 12-in. 38-ton muzzle-loading Woolwich gun, of wrought iron with a steel tube. It occurred in the turret of the *Thunderer*, and was particularly disastrous. Besides serious damage to the turret and deck, 11 men were killed and 36 wounded. A long series of experiments were made with a sister gun, which was also burst, and the conclusion reached was that the accident probably came of double-loading, but of this there never was any but circumstantial proof. It is, of course, true that none of these guns were of recent construction and none of them of all steel, yet even with the later models, the record is not altogether reassuring. We have a recent report of ten 9.2 in. Woolwich guns having failed during test. Of these, nine were from rupture of or accident to their inner tubes, and but one from fracture of the outer casing. To these may be added the failure of a 10-in. Woolwich gun during trial in January, 1888, in which case the tube ruptured half way between the trunnions and the muzzle, the front portion being blown entirely out of the casing.

The necessity for additional longitudinal strength was clearly shown in the explosion of the 100-ton Armstrong gun on board the *Duilio*, one of the monster Italian armor-clads, in March, 1880. The gun was a muzzle-

loader, and composed of a steel inner tube, surrounded by wrought-iron coils. This inner tube parted at the junction of the powder-chamber with the bore proper, and the whole breech of the gun was violently thrown back against the side of the turret with sufficient force to indent the inner skin and force open two of the outside 22-in. steel armor plates. The peculiarity of this accident was that, after striking the wall of the turret, the breech rebounded and resumed nearly its normal position on the muzzle portion of the gun, which had remained on the carriage. It might be added that, unlike the *Thunderer* accident, no loss of life resulted, two men only being burned by the escaping gas.

The accidents to the new type of English breech-loading guns led, some five years ago, to the appointment of a special committee, composed of recognized authorities on gun construction, to whom were submitted designs for strengthening guns already made, those in course of construction, and an alteration of plans of those to be made in the future. The recommendations of the committee may be summarized as follows: The hooping of all guns to the muzzle; guns under construction to have the chase formed of a double tube, or tube in two thicknesses, with the addition, in certain designated calibers, of a thin liner extending from the end of the powder-chamber to about half the length of the tube. Recent accidents would indicate that some radical fault still exists in their system of gun construction, unless it is attributed to the metal, which is hardly likely.

No system of gun construction can hope to escape without some failures, and that system may be considered the best in which the casualty list is the smallest. Judged by such a standard any comparison between the English and Krupp's system—which is one often made—can only be to the disadvantage of the former. With regard to English ordnance one may be pardoned the criticisms made upon it, in the light of the statements and protests one finds in their own journals and from English military critics.

The record of Krupp ordnance has been exceptionally good. Krupp confesses to 25 accidents to his guns in a period of 30 years, nine of them occurring since 1868. Excepting two field guns, damaged in the chase by premature explosions, these accidents were all to guns of old model. With more than 20,000 guns of various calibers fabricated and in use all over the globe, one might say, a casualty list of many times this number would still leave the record a good one.

IX.—BREECH MECHANISM.

As concerns breech mechanism there are two systems: one known as the wedge, or Krupp; the other, the interrupted screw, or French fermature.

The Krupp fermature consists of a cylindro-prismatic block, or wedge, working perpendicularly to the axis of the gun. Toward the bore of the gun this block presents a flat face, but toward the rear it is cylindrical, with a slight taper. This block slides in an opening of similar size and shape at right angles to the bore. When the breech-block is withdrawn as far as it will go—to the left—the bore of the gun is left free. When it is shoved home the breech is perfectly closed. In field guns the breech-block is moved in and out by hand. In larger calibers this is done by aid of a screw. In both cases it is driven home and locked by a second screw. Obturation is obtained by means of the Broadwell ring and gas-plate—a thin ring of steel let into a recess at the end of the bore, and against which abuts a flat plate fitted to the face of the breech-block, or wedge. Upon firing the pressure forces the ring against the plate and cuts off all escape of gas. The vent is axial and through the breech-block, and is provided with an obturating primer which prevents all escape of gas. This arrangement is shown in fig. 4.

The French system is, as stated above, of the interrupted screw pattern. The breech-screw seat is cut in the rear end of the inner tube or body of the gun and in prolongation of the bore. It has an interrupted screw thread, each alternate sixth part being planed off to correspond with similar divisions on the breech-screw. When the breech-screw is inserted, the sixth of a turn engages, of course, the three sections of screw into the corresponding threaded

sections. The breech-screw is supported, when withdrawn from its seat, by a carrier-ring hinged on one side, so that it can be swung out of the way, entirely exposing the powder-chamber and bore. When shoved home it is secured by a latch-hook. The De Bange gas check is used. A stalk, secured at the rear, passes through the breech-block and has a mushroom-shaped head projecting into the bore. Around the neck of the stalk and just under the head of this mushroom is a collar of asbestos and tallow, secured in a cotton cover and supported in place by two convex tin guards. When the gun is fired the mushroom head is pressed back upon the asbestos collar and forces it against the walls of the bore. An obturating primer, as in the other system, cuts off escape of gas by the vent. This system is shown in fig. 5.

In comparing these two systems of fermature one cannot but believe that the Krupp system is by far the better one. In it the tube or body of the gun is not called upon to bear any of the longitudinal strain. The enormous backward thrust of the powder-gases is taken up by the heavy jacket and carried direct to the trunnions. The

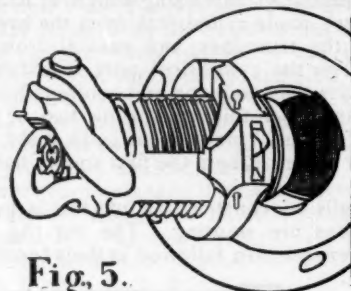


Fig. 5.

The French Fermature.

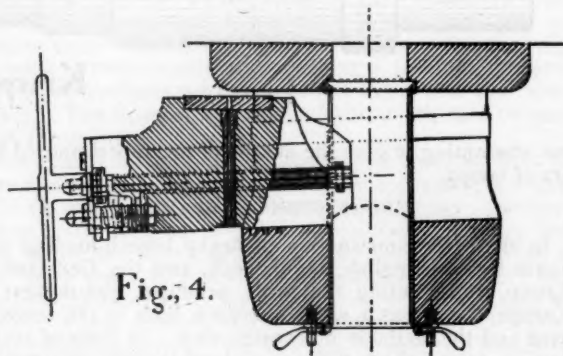


Fig. 4.

The Krupp Fermature for Heavy Guns.

mechanism is simple, and admits of the aiming of the piece before the completion of the loading.

On the other hand, in the French system the gun-tube has to bear not only the transverse but the longitudinal strain as well. The entire pressure on the breech-block must be borne by the screw-threads. That these should sometimes strip, frequently become jammed, or that rupture should here take place, is not to be wondered at. The perfect and equal contact between the screw and threaded portion of the seat, so that every part shall bear an equal strain, is next to impossible to obtain. The danger arising from imperfect locking of the breech, and the liability of the breech-block to work loose in high-angle firing, are other objections to the system. That it possesses certain advantages in the matter of manipulation over the wedge system will not be denied, but that it is as safe, possesses the endurance, or is not more liable to get out of order than the former, cannot be admitted.

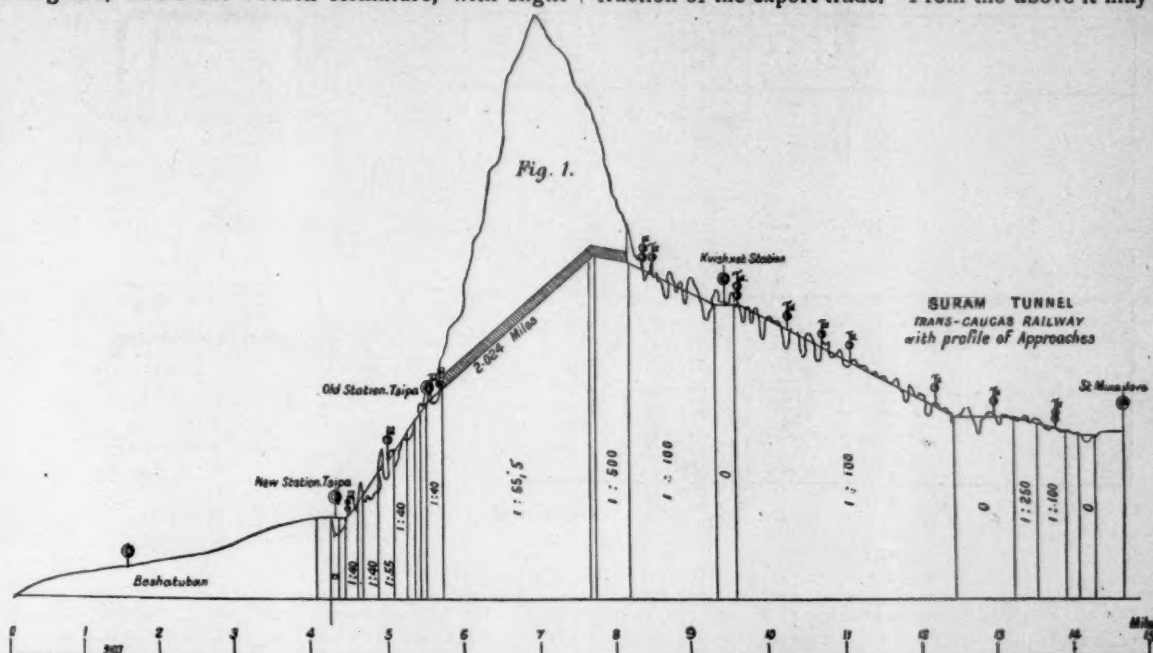
A long list of accidents to French guns, extending over the past five years, could be given, showing the inherent weakness of the system. Guns have been torn apart, breech-blocks blown out, or the breech blown off in at least a score of cases, with a loss of life to gunners and

cannoneers that exceeds the famous massacre of blue-jackets by our rotten cast-iron Parrott guns at Fort Fisher. Added to a long list of previous failures of field guns, we have an account of the failure of a 34 cm. De Bange gun in August, 1887. In December last another 34-cm gun was unbreeched in the turret of the *Amiral Duperré*, while engaged in practice-firing, killing two officers and five gunners. The failure of these guns was attributed, by the advocates of the French system, to the fact that they were guns of the model of 1875. The recent failure of a new 34 cm. early in its trial, by the giving away of the whole breech, remains to be explained in some other way.

In England, where the French fermature, with slight

working capacity of the whole Trans-Caucasus Railroad has been obliged to be measured by the transport capacity of this short but exceptional section of the line.

When the tunnel is completed the greatest grades encountered when running west will be no more than 1 per cent., with curves of a minimum radius of 910 ft., and in running east 2.5 per cent. As it is assumed that this line will have more traffic from east to west, on account of the ever-increasing petroleum, Persian, and middle Asian export, it is considered that the still remaining grades of 2½ per cent. going east will not prove a serious obstacle, as the import trade from the Black Sea side forms but a fraction of the export trade. From the above it may safe-



modifications, has been adopted, they have been only a little less unfortunate than across the Channel. In English guns the breech-screw is seated in the jacket and not in the gun-tube, which does away with one source of weakness. An English military critic, writing in January last of the unfortunate cruise of the *Impérieuse*, says: "Two months ago her captain, William May, the crack gunner of the English Navy, was rash enough to have her 6-in. guns fired. Several locks were promptly blown out of the breech-pieces, a space having been left between them so as to allow the charge to have effect backward. The main deck battery was thus as useless as the boilers." Another writer, speaking of the same occurrence, says: "The crew having been forced to lie down to escape this modern kind of raking fire, while merely firing at a mark, is both a novel experience and a somewhat unpleasant foretaste of what might and probably would occur in action."

(TO BE CONTINUED.)

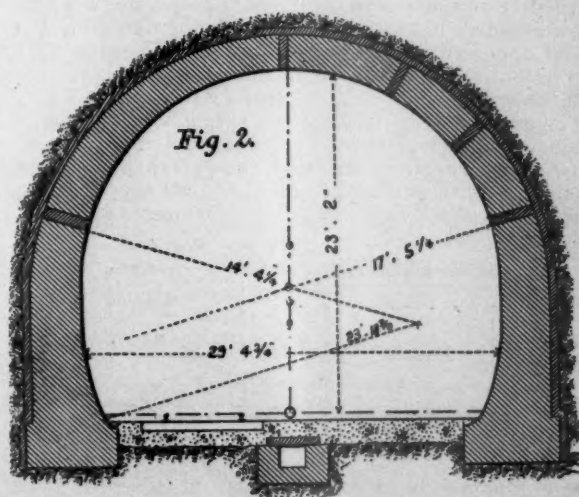
THE SURAM TUNNEL.

(Mr. Thomas Urquhart, in London *Engineering*.)

SINCE the Trans-Caucasus Railroad was built from Batoum to Baku, the enormous development of its traffic, owing to the discoveries of petroleum at the eastern end of the line, has made prominent the obstacle to traffic interposed by the grades of present line over the Suram Pass. Between Baku and Michailova, a station at the base of the mountain on the Asiatic side, the profile of the line presents no remarkable features, but between Michailova and Beshatuban on the European side of the mountain and over the Suram Pass the profile rises at the rate of 4.5 per cent., with curves of 560 ft. radius for a distance of 19 versts. Thirteen trucks, being a load of 210 tons, require on this exceptional section two Fairlie locomotives, each of 65 tons adhesive weight, one engine in front, the other in rear of the train, so that hitherto the

ly be assumed that the capacity of the Trans-Caucasus Railroad will be materially increased, thanks to the use of the tunnel, even with the single line at present contemplated, at least by 100 per cent. The total length of the line will, on account of the tunnel and its approaches, be increased from 840 versts, Baku to Batoum, to about 849 versts, or 563 English miles.

In the accompanying engravings, fig. 1 is a profile of

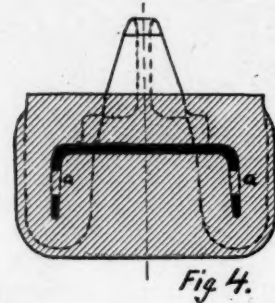
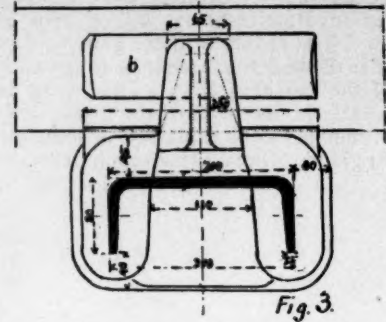
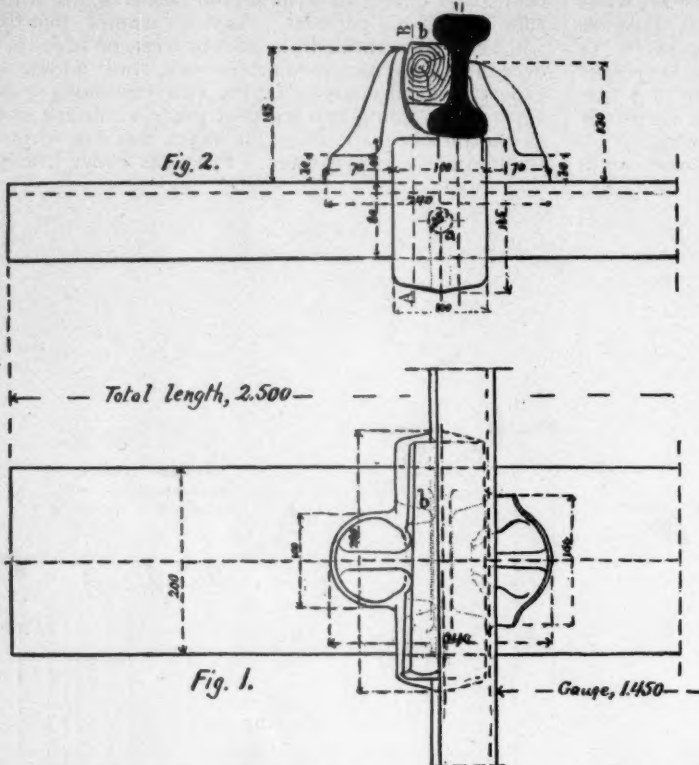


the tunnel and its approaches; fig. 2 is a cross-section of the tunnel in its finished state; figs. 3 and 4 are cross-sections of the temporary heading. It will be noticed the tunnel is intended for a double line, Russian 5 ft. gauge; the total length of tunnel is 3.73 versts, or 2.47 miles English.

The tunnel is being made by the Russian Government, and is calculated to be completed on January 1, 1890, at

an estimated cost, including approaches, of 10,000,000 roubles (\$5,000,000). The work is subdivided among various contractors. The firm of Brandt & Brandan, Prussian engineers, have undertaken the piercing of a heading 8 ft. 9 in. by 8 ft. 9 in. (fig. 3) in the clear between sup-

as the English system. The hydraulic appliances, along with Brandt's machines, are all arranged for 100 atmospheres pressure, which was the pressure used in the tunnels of the St. Gothard Railroad, but owing to the rock here being of a soft character, 30 atmospheres is suffi-



ports, for 360 roubles per lineal sashin (7 ft.), or about \$25 per lineal foot, the Government supplying all workshops, steam and hydraulic power, machine tools, rolling stock, locomotives, etc., at its own expense. A premium of 150 roubles (\$75) per day is awarded to Messrs. Brandt & Brandan for each day saved in completing the heading under the contract stipulation, a mean lineal distance of 9 ft. 4 in. being considered a normal day's work for each face; the effect of this award is that the work is continuous day and night.

Profiting by the experience gained recently in the construction of tunnels in Southern Europe, the appliances now adopted at the Suram Tunnel are naturally of the most approved construction. The drilling-machines are on Brandt's hydraulic system, similar to those used at the Pfaffensprung Tunnel, St. Gothard Railroad.

There are four locomotives specially made for this tunnel by Messrs. Struve, engineers at Colomna, near Moscow; these engines are of Krauss's type, having their boilers inclined so that the tubes are level notwithstanding the incline of the rails. They are 0.90 meter gauge; two

cient; the average work done in 24 hours is 20 ft., which is much greater than the progress made in the St. Gothard tunnels. The number of holes bored in each attack is seven, of an average depth of 4 ft. 10 in., an average daily consumption of 106 lbs. of dynamite being used at each face.

METALLIC TIES IN FRANCE.

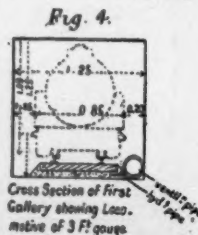
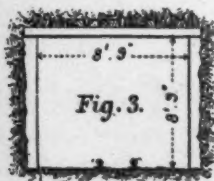
[Note by M. Clerc, Chief Engineer of the Western Railroad of France, in the *Revue Generale des Chemins de Fer.*]

THE question of metallic ties is the order of the day, and a number of systems have been tried. We may say that, in general, they have not proved satisfactory, and that only a few can support a careful examination.

It may be remarked that among the various types brought forward a few only are the invention of persons who have had experience in maintenance of way on railroads. This is explained by the fact that, while the iron and steel mills have a deep interest in the adoption of metallic ties, a majority of the engineers in railroad service—in France, at least—prefer wood, and the only reason which seems to them to justify the substitution of iron or steel is the difficulty of procuring timber for this purpose.

We cannot yet foresee the time when the scarcity of timber will compel the general adoption of metal. The price of wooden ties in France is to-day lower than for 30 years past, a fact which is explained by the greater facilities of transportation and the opening up of new districts by railroad extension. On the other hand, the life of wooden ties has been notably lengthened by the use of various processes for preserving them. We cannot yet assign a limit to the life of creosoted beech ties, although such ties have been in use already for 25 years. At the end of this long period of service such ties are found in a perfect state, and have not been replaced on account of decay—except in a few cases, where the preparation was imperfect—those which have been renewed having failed on account of splitting, cutting by chairs, or other mechanical causes.

However this may be, the question demands study, and



are 15 tons weight each, and two are 10 tons each; all are fitted with Urquhart's petroleum firing appliances. In order to obviate smoke in the workings, steam is got up to 15 atmospheres out in the open, in the exceptionally large boilers, so that no necessity arises to start a fresh fire while in the tunnel, the accumulated heat in the brick-work of the furnaces serving to keep the steam up and preventing cold air getting at the tube ends, thus preventing leakage.

The heading is driven at the bottom of the tunnel, known

the object of the present paper is to present the result of trials made on the Western Railroad.

Most systems of metallic ties present the same defects—insufficient resistance to the transverse shocks which tend to spread the rails on lines where trains are run at high speed, and difficulty of obtaining a solid fastening for the rails by means of the keys, bolts, or rivets generally used. On lines of large traffic all those which have been tried in a short time show so much play, on account of the enlargement of the bolt or rivet-holes, that they have been put out of service.

In our trials we have tried to avoid these objections, and the device we have reached is shown herewith. In these illustrations fig. 1 is a half plan of the tie; fig. 2 a half elevation; fig. 3 is a cross-section; fig. 4 is another cross-section, on the line *A B*, fig. 2. The arrangement is for the double-headed pattern of rail, with chairs, which is generally used on our lines; but it could easily be adapted for a rail of the Vignoles pattern.

The tie itself is a bar of steel of inverted Ω shape, 0.20 meter (7.87 in.) in width, 0.08 meter (3.15 in.) in height and 2.50 meters (8 ft. 2.5 in.) in length. The gauge of the road is 4 ft. 8½ in. At the proper points there are cast on the tie itself chairs of cast iron which are prolonged below in such a way that they entirely surround the steel bar for a distance of 0.10 meter (3.93 in.). The chairs thus cast are fixed solidly on the tie by the shrinkage of the iron and, to prevent any working loose in service, holes are drilled in the tie as shown at *a a a*, figs. 2 and 4, or else the tie is serrated at the bottom. The holes are filled with cast iron, forming a pin solid with the chair, so that any movement is impossible.

In this way a tie is obtained forming practically one piece with the chairs, and without those movable pieces or attachments which form so serious an objection. The rail is fastened in the chair by the wooden key or wedge *b b b*, figs. 1, 2, and 3.

The resistance of this tie to transverse movement is considerable. The cross-section of the tie and the mass of cast iron which accompanies it is $0.280 \times 0.165 = 0.0462$ square meter for each chair, and consequently its bearing surface on the ballast, to resist lateral movement of the track, is twice that, less the sectional area of the track, that is:

$$2 \times 0.0462 - 0.00275 = 0.08965 \text{ sq. m.}$$

With an ordinary metallic tie this bearing surface, counting that presented by the base of an ordinary chair, and taking the same sectional area for the tie, would be only:

$$\frac{0.00275}{2} \times 0.05 \times 0.10 = 0.01275 \text{ sq. m.}$$

With a wooden tie, under the same conditions, this bearing surface would be:

$$0.22 \times 0.14 + 2 \times 0.05 \times 0.10 = 0.408 \text{ sq. m.}$$

These figures show that the section by which the tie in question bears against the ballast, to oppose lateral movement of the track, is about seven times as great as that of ordinary metallic ties and more than twice that of a wooden tie.

We must also remark that, in consequence of the arrangement of the mass of iron which surrounds the tie, the rail is supported for the whole length of this piece of iron—about 0.25 meter—instead of being carried for 0.10 meter only, which is the width of an ordinary chair. The surface by which the rail is supported is thus about 2½ times as great with this tie. This presents the advantages of reducing the distance between the bearings, of producing a more complete support, and of diminishing the gaps which tend constantly to arise between the rail and the chair. These advantages seem to have a certain importance.

The weight of a tie of this kind is about 110 kilogs. (242.5 lbs.), of which the steel tie forms 60 kilogs. and the cast iron 50 kilogs. The price at present is 14 francs (\$2.73) each, the steel bar costing 9 francs and the cast iron chairs 5 francs. This price is no greater than that of most of the metallic ties proposed, considering that it is ready to receive the rail without any additional supports or fastenings.

The Western Railroad Company, after trying ties of this type for two years on sections of the road where the traffic is heaviest, has just ordered 5,000 more of the same kind, with some slight modifications in detail, suggested by experience, and intends to continue the test on a large scale.

NOTES ON STEAM HAMMERS.

BY C. CHOMIENNE, ENGINEER.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(Continued from page 222.)

CHAPTER XLVIII.

THE HYDRAULIC FORGING PRESS.

BEFORE making a comparison between the hammer and the hydraulic press, we must first give some description of this last apparatus. The HYDRAULIC PRESS is generally composed of three parts.

1. The compressing pumps.
2. One or several accumulators.
3. The receiver or body of the press, properly so called.

The compressing pumps transform into hydraulic energy a certain volume of water per second, under a determined pressure; their duty is regulated by the volume of water per second used by the apparatus which they supply. The pressure of water can be increased without changing the duty, as it is sufficient for that purpose to increase the speed of the pump. In the same way we can increase the duty while maintaining a constant pressure.

In order to secure the best working of the pump, the water should reach it at a light pressure; in this way all the trouble due to drawing in air at a certain depth is avoided.

The work done by a hydraulic receiver varies with a volume of water used and with the pressure.

The loss of the total charge required to fill the admission passage as well as that of the return passage are both proportional to their length, and inversely proportional to the section of the pipe. In order, then, to reduce this loss to a minimum we must make the passages as short as possible, especially that of pressure, reduce the volume of water used, and make the pipes of the largest possible section. The joints of the pressure conduit must be made with carefully fitted and packed flanges and with the greatest care; those of the return passage where the pressure does not generally exceed 10 kilogs. may be made like those of ordinary water-pipes.

Two sorts of accumulators are used.

1. The ordinary accumulator of large diameter, for cases where large quantities of water and light pressure are necessary.
2. The differential (Tweddell) accumulator in cases where a small volume of water and a very high pressure are employed.

The accumulator consists of a plunger-piston, loaded with a certain weight and moving in a cylinder, inside of which the water is brought up to the pressure of the accumulated charge on the piston.

The accumulator is especially advantageous when the work is intermittent, as happens with many tools in workshops, such as shears, punching machines, riveting machines, and forging presses; but its use is not of any advantage where the work is continuous.

CHAPTER XLIX.

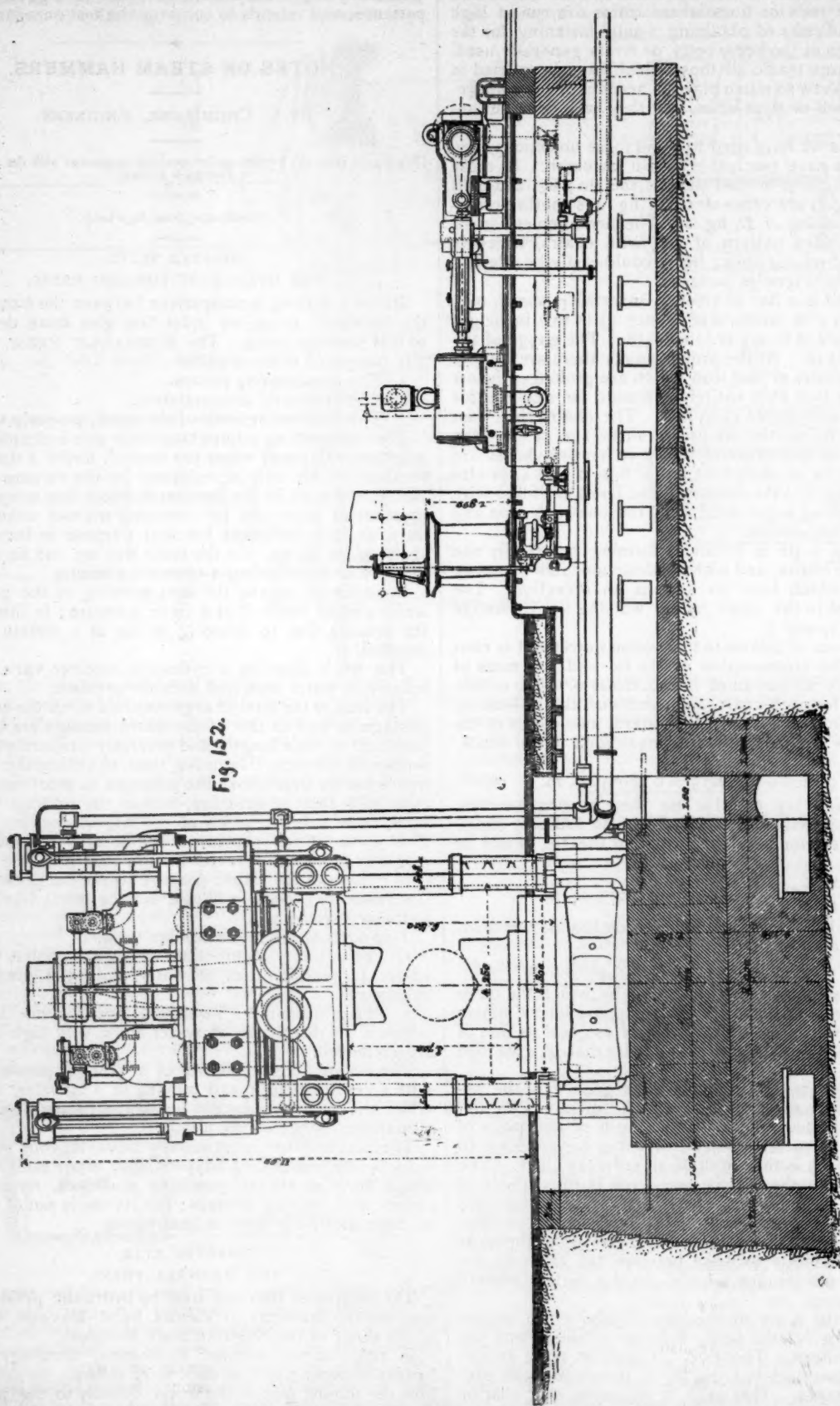
THE HASWELL PRESS.

The forging of iron and steel by hydraulic pressure was used for the first time, at Vienna, by M. Haswell, Director of the shops of the Austrian State Railroad.

In 1862, at the London Exposition, drawings of the hydraulic press which he used were shown. In this apparatus the pumps forced the water directly to the piston of the press, and they were worked by a very large steam piston, the distribution of the steam being regulated by a jet-valve. This press was used to forge axle-boxes, cross-

heads, and similar pieces, and also the detached pieces of locomotives and tender wheels; it was also used for drawing out ingots of iron and steel.

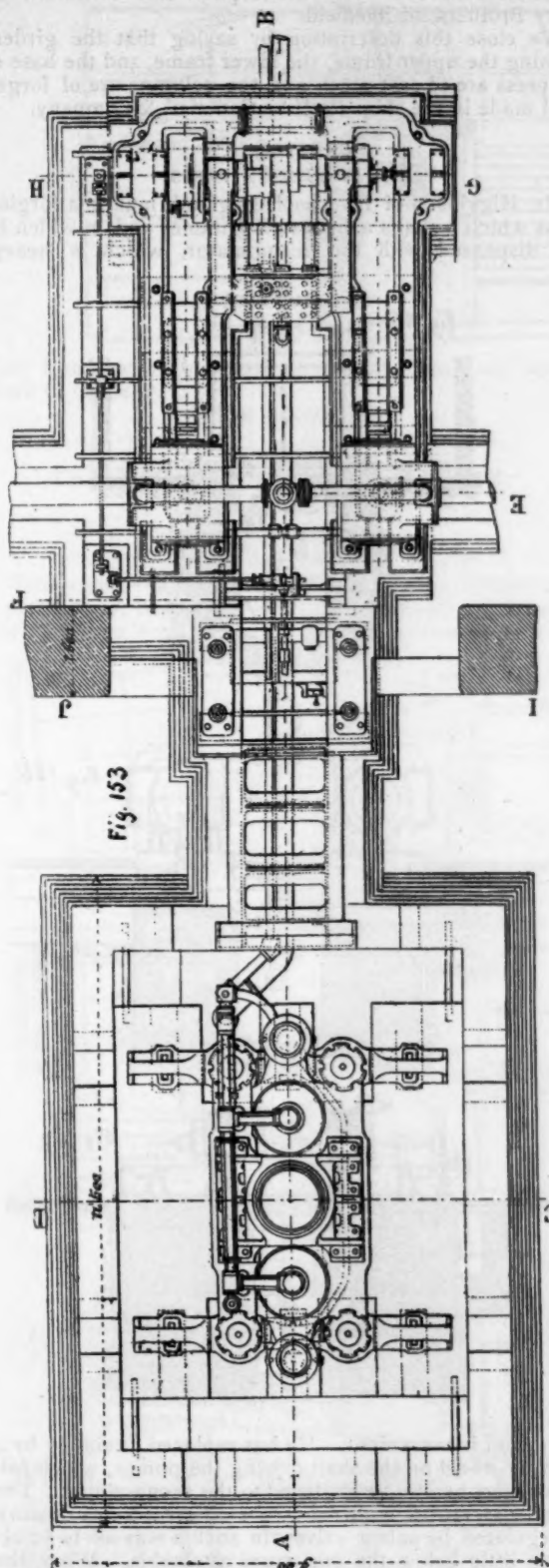
which was 1,500 tons. Borsig, at Berlin, and Krupp, at Essen, had also installed in their shops similar presses to be used for the same work.



In 1873 MM. [de Dietrich & Company had erected in their shops at Reichsoffen a Haswell press, the power of

The use of the Haswell press has not become very general. It is only within a short time that certain construc-

tors like Whitworth and Davy Brothers, at Sheffield, and Higginson, at Liverpool, have improved this tool. They have not hesitated to apply it to the forging of artillery material and to all pieces where uniform quality is required



and which must be worked sometimes at as low a temperature as a dull red. They have also substituted a progressive and continuous pressure of the hydraulic press, for the violent shocks of the steam hammer, and in this way have reduced very much the slow and costly construction which characterize those tools, in this way making a very important improvement.

CHAPTER I. THE DAVY PRESS.

This press, which is represented in figs. 152, 153, 154, 155, 156, and 157, was built by Davy Brothers, in Sheffield, England, for the shops of Cammell & Company of the same city, from the designs of Mr. Charles Davy, who has taken out patents in all the States of Europe and the United States.

This press is composed of two large pistons, each 0.915 meter in diameter and 2.820 meters stroke, separate from each other, and of two relieving pistons 0.230 meter in diameter and 2.135 meters stroke. The press cylinders are carried by a solid frame or table resting upon two girders, each 1.515 meters in depth, joined by two shorter girders forming cross-braces. A similar but heavier plate or table forms the base of the press, which is united to the frame by four large bolts, or columns of steel, 0.508 meter in diameter; the distance from the base to the supporting frame is 6.400 meters and the columns are 4.570 meters between centers in one direction and 1.930 meters in the other.

The movable part—carrier or hammer-head—has the form of a T; it is guided at the end by slides fastened to the column and above by a long rod working in a hollow column bolted to the upper frame. The slides below are in two pieces fastened together by keys, sufficient play being allowed for expansion when the columns are heated by radiation from the piece to be forged.

For the same reason—the necessity for allowing for expansion—it is evidently impossible to attach the piston-rods rigidly to the head, and so these rods are made with spherical ends, which simply rest on the head. It will be seen in this way that the head is kept in an upright position entirely by the guides and the hollow column above, and that the lateral pressure on the columns is hardly appreciable. It is hoped, therefore, that all these parts and also the leather packing of the pistons will last for a long time.

This system adopted by Mr. Davy, of guiding the head independently of the pistons, permits the forging to be placed on the anvil-block wherever convenient, even if it is not exactly in a central position, without the fear of breaking the piston.

The substitution of two presses, or cylinders, for the single one previously employed possesses other distinctive advantages and increases its usefulness and security. The girders forming the upper frame are comparatively light, weighing about 28 tons each. The distance from the axis of the columns to the axis of the body of the press is only 0.876 meter. The principle being thus admitted of reducing the extreme width of the frame to the smallest possible dimension, the chains which hold the forging can be placed at a very short distance from the anvil if necessary.

The hydraulic power is furnished by three single-acting pumps, each 0.152 meter diameter and 0.305 stroke, driven by a shaft with three cranks, which is attached to a steam engine with two cylinders, each of 0.865 meter diameter. These pumps are fed by a column of water in which the pressure is 4.600 kilogs. per square centimeter, in such a way that very light admission valves are necessary, and the advantages are little play and very slight repairs. The use of water at a low pressure is best for the press itself; it is required to secure the rapidity of action which is so desirable and to prevent the infiltration of air into the passages and cylinders.

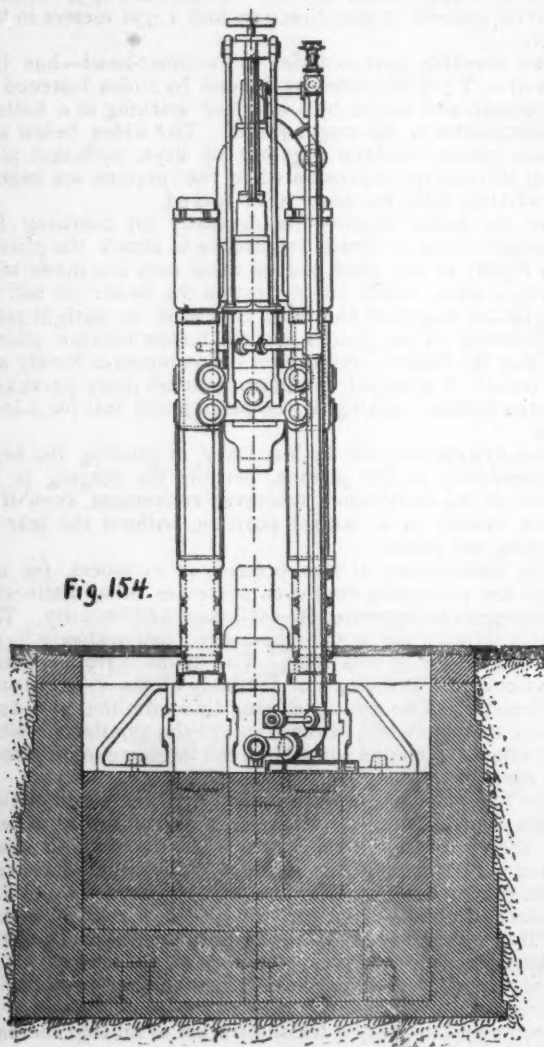
The hydraulic pressure is 330 kilogs. per square centimeter at the level of the pumps, and depends on the resistance of the forging to compression.

The capacity of the pump is such that at each revolution the hammer-head descends 0.012 meter, but it raises itself 0.200 at each revolution, the areas of the relieving piston and of the forging piston having a ratio of 1:16.

The pumps can work up to 60 revolutions per minute and even higher, so that the descent and relief of the piston can be effected at a considerable speed.

Although the forging pistons work rapidly under the action of the pump, they are still not quick enough to give a certain play between the upper head and the forging when the latter is turned into a new position. If we sup-

pose a simple round shaft placed under the press the head must be raised after each operation at least 0.150 meter above the forging, to permit it to be turned. This play is obtained with a speed of 0.610 meter per second by putting the small or relieving piston into communication by means of large valves with the low pressure. Without describing in detail the arrangement of the valves and of the tubes for high and low pressure, which are shown clearly in the illustration, the action of the press will be easily understood. When it is necessary to raise the head some centimeters above the piece to be forged the escape valve of the relieving pistons is first opened. The forging piston being at this moment opened to the low pressure the head descends rapidly until it rests on the forging. The pumps are then put in motion, the large valves of the forging pistons are closed automatically, cutting off the connection with the column of water at low pressure and opening it with that at high pressure. As soon as the required com-



pression has been effected the head is raised rapidly for another blow. Two levers only are necessary to control the three motions, one for the press itself and the other to start the pumps.

By following this method of operation the position of the head is regulated automatically whatever may be the thickness of the forging.

The working of this press is as easy as that of a steam hammer, because a forging having a rectangular section can be pressed alternately on the flat and on the edge without the necessity of moving it to the center of the anvil.

The forge built by Cammell & Company is a brick building 78 by 18 meters, with two wings covering the

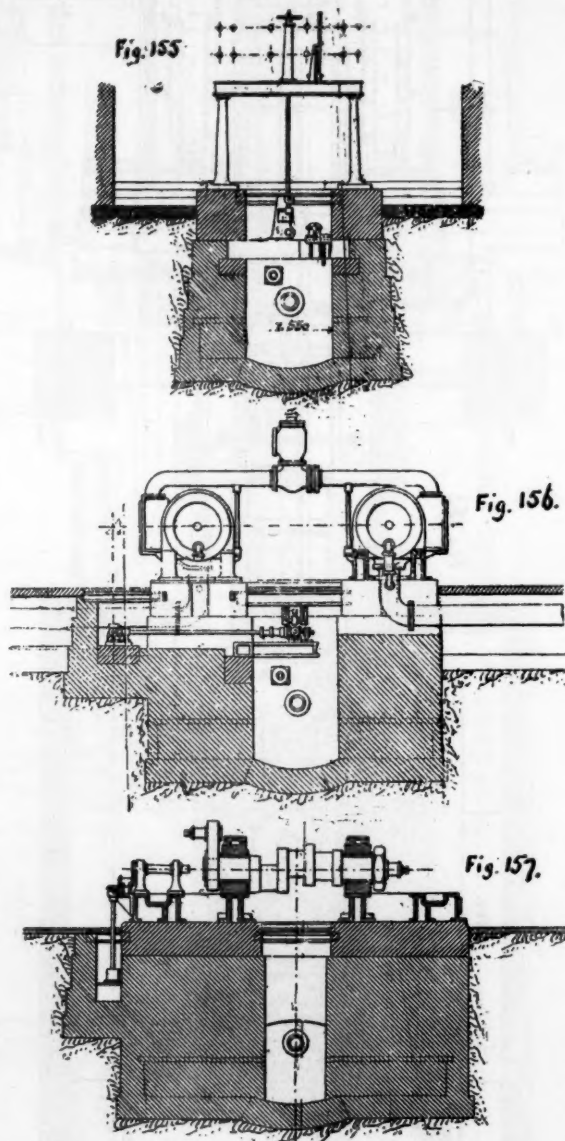
furnaces. The press is in the center of the building, one furnace being placed at each side. Two overhead cranes, one of 110 tons and one of 150 tons, serve the press and both the furnaces. The whole plant was furnished by Davy Brothers, of Sheffield.

We close this description by saying that the girders forming the upper frame, the lower frame, and the base of the press are of cast steel, and the columns are of forged steel made in the shop itself by Cammell & Company.

CHAPTER LI.

THE HIGGINSON PRESS.

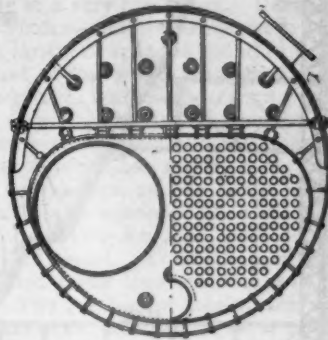
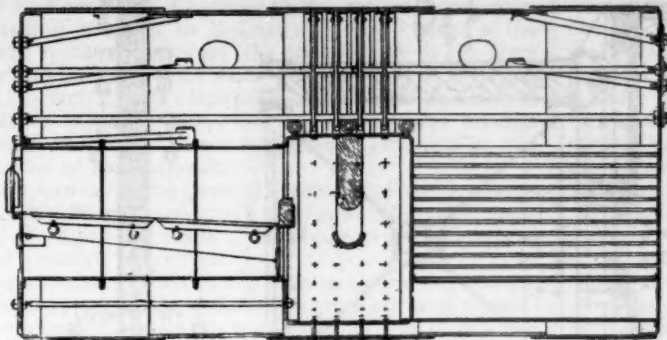
Mr. Higginson of Liverpool, England, makes a forging press which he calls a hydraulic hammer and in which he has dispensed with the accumulator, which is heavy,



costly, and inconvenient. He has replaced it simply by a heavy fly-wheel on the shaft driving the pumps, which fulfils the part heretofore intrusted to the accumulator. The different pressures required by the different kinds of work are regulated by safety valves, in such a way as to be always a little below the maximum attainable. When the press is not at work the pumps simply cause water to circulate through the passages. When the water is admitted to the piston the part of the stroke in which it has no work to do is accomplished by water at a pressure only a little above the ordinary circulating pressure; but when the piston meets with resistance the pressure is rapidly raised and the work is done at the expense of the power stored up in the heavy fly-wheel.

So far only three sizes of these forging presses have been built; these have a power of 50, 100, and 150 tons, which, according to the builder, are equivalent respectively to hammers of 500, 750, and 1,000 kilogs. These presses can

the credit of English engineers, who, it is fair to say, have taught the technically-educated German one more lesson. The *Calliope* was built at Portsmouth dockyard in 1883; she is of a class slightly larger than the original "C"



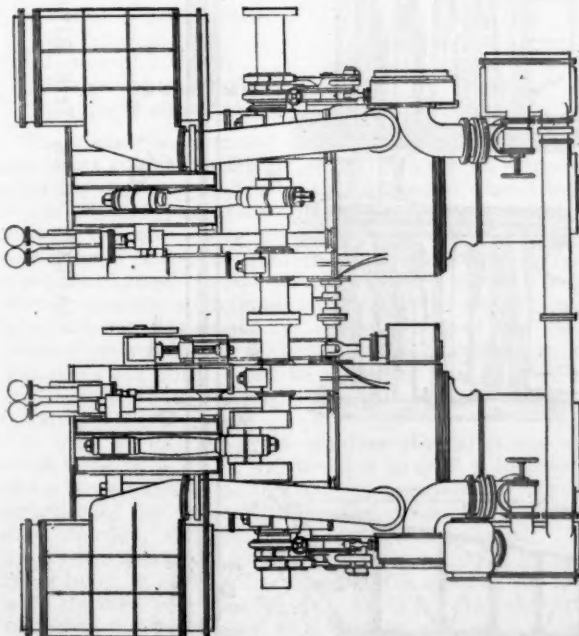
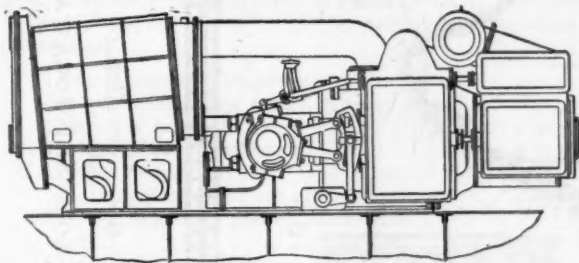
give from 20 to 40 blows per minute according to the work to be done.

(TO BE CONTINUED.)

THE ESCAPE OF THE "CALLIOPE."

(From the London Engineer.)

THE sensational escape of the British ship *Calliope* from Apia Harbor, Samoa, deserves to be placed on record in our pages, as it was, in one sense, wholly due to the excel-



lence and sufficiency of her machinery. In it her captain placed implicit confidence, and his confidence was not misplaced, the *Calliope* being literally forced by her engines in the teeth of a tornado. For some time she did not make half a knot an hour, but she held her own, and ultimately steam and iron beat wind and water, much to

class, as an improvement on that class; her length is 235 ft.; beam, 44 ft. 6 in.; with a displacement of 2,770 tons, and a larger proportion of engine power to displacement than vessels of that class, her machinery being of 3,000 H. P. in place of 2,300 H. P., with natural draft, to which was added an arrangement for moderate forced draft after the completion of the trials of the engines. The engines were made by Messrs. J. & G. Rennie, of Blackfriars, London; are of the horizontal double piston-rod tandem description, with four cylinders, the high-pressure cylinders being of 42-in. diameter and the low-pressure, of 72-in. diameter, with a stroke of 36 in., making about 90 revolutions per minute, at full power with natural draft. The boilers, six in number, are of the ordinary horizontal type, the tubes being in a line with the furnaces, placed in two groups of three boilers, each boiler being 18 ft. 3 in. long by 9 ft. 2 in. diameter, with a total heating surface of 9,254 square feet, and grate surface of 301 square feet; working steam pressure, 90 lbs. The surface condensers are entirely of gun-metal, with a condensing surface of 6,000 square feet.

The engines were made originally very strong throughout, with the view of the addition of increased power by forced draft, and the screw was made on the feathering principle. The engines of the *Calypso*, a sister vessel, were also made by Messrs. J. & G. Rennie.

We give also two sections of one of the boilers, which are of a type much used in the Navy when it is necessary to keep down weight. These boilers have proved efficient, and steam well when properly handled.

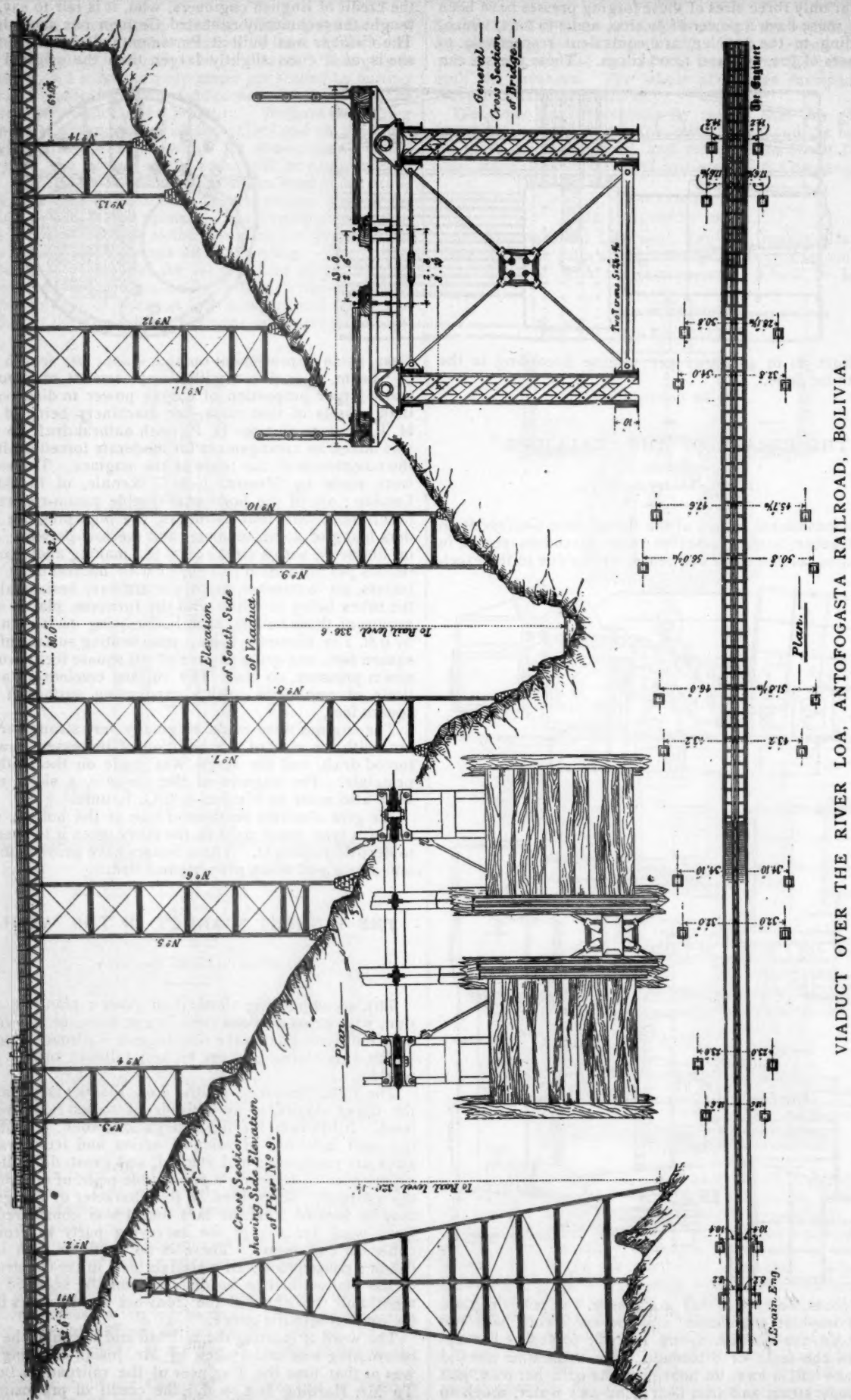
THE HIGHEST VIADUCT IN THE WORLD.

(From the London Engineer.)

THE accompanying illustration gives a plan and elevation, with cross-sections on a larger scale, of the viaduct over the River Loa on the Antofagasta Railroad in Bolivia, which, it is claimed, is the highest railroad bridge in the world.

The cañon spanned by the Loa Viaduct is situated in the upper Andes, at an altitude of 10,000 ft. above sea-level. It has been formed through solid rock, probably by the joint influence of volcanic action and ice-flows. Its sides are precipitous and rugged, and great difficulty was experienced in selecting a practicable point of crossing for the railroad. Some idea of the character of the ground may be formed from the fact that it was considered very good work for any of the surveying party to cross the cañon in two hours. There is no available path up the cañon; consequently all materials used in the construction of the viaduct had to be delivered on the seaward abutment, and the whole of the ironwork for the piers had to be lowered into the gorge.

The work of locating the railroad and selecting the point of crossing was undertaken by Mr. Josiah Harding, who was at that time the Engineer of the railroad in Bolivia. To Mr. Harding is also due the credit of proposing the



general character of the structure, and fixing the positions of the piers.

After the main features of the proposed viaduct had been submitted by Mr. Harding to Mr. Woods, and approved by him as Consulting Engineer to the railroad company, Mr. Harding returned to Bolivia, and took charge of the necessary masonry work for the foundations of the piers and the abutments. This work was executed in anticipation of the arrival of the ironwork from England, and it is satisfactory to know that when the viaduct was erected there was not the slightest adjustment required in the foundations or the ironwork.

After approval of the general character of the proposed viaduct, Mr. Woods undertook the responsibility of making the necessary calculations and designing the details, a work of no small magnitude.

In the absence of trustworthy data as to the force of the wind during hurricanes, which sometimes occur of considerable violence, blowing up the cañon, it was decided in making the calculations as to stability to take the maximum possible wind-pressure at such an intensity as would be sufficient to blow a train of empty trucks off the viaduct, the condition of least stability being when the viaduct is loaded with an empty train. This pressure was carefully computed, and the result obtained adopted in the subsequent calculations for stability. Supposing such a pressure had at any time to be withstood by the viaduct—which is very improbable—there would then be a large margin of stability. It should be remembered in connection with the question of wind-pressure, that the weight of the atmosphere, at the great altitude at which this viaduct is erected, is only about two-thirds of that at sea-level, the barometer standing at about 21 in. of mercury.

The following are some of the principal particulars of the viaduct:

Length between abutments	800 ft. 0 in.
Height from water to rail level....	336 ft. 6 in.
Length of longest column	314 ft. 2 in.
Length of principal spans	80 ft. 0 in.
Length of pier spans.....	32 ft. 0 in.
Width of platform over all.....	13 ft. 0 in.
Width, center to center, main girders	8 ft. 10 in.
Depth of main girders, centers of booms.....	7 ft. 11 in.
Batter of outer columns.....	1 in 6
Batter of piers.....	1 in 3
Gauge of railroad	2 ft. 6 in.
Weight of ironwork.....	1,115 tons.
Rolling load per foot.....	1½ tons.

The viaduct was erected without any temporary staging, this being effected in the following manner: A wire-rope tramway was constructed across the cañon, consisting of two of Messrs. John Fowler & Company's strongest steel plowing ropes spanning the gorge from side to side, being a clear span of 800 ft. And on this aerial road a carrying truck was hauled backward and forward by steam winches placed upon the abutments; all the parts of the piers were launched on this tramway, and when over the places where they were required, were lowered by suitable tackle. The piers are constructed in stages, so that as each tier was completed a working platform was formed for the construction of the next.

It may be interesting to mention that after the wire ropes were in place, it was decided to send a locomotive and a large quantity of the material required for the construction of the railroad across the cañon by the means they afforded, and this was safely accomplished. The locomotive was taken to pieces, but the weight of its boiler being much in excess of any part of the viaduct, the ropes were strained very heavily by its transit. However, they withstood this exceptional trial most satisfactorily.

As the piers were completed, the girders forming the superstructure were placed in position by means of a crane, sent out with the ironwork from England, and constructed to lift the longest girders—80 ft. span—in one piece and place them in position. This crane was worked by hand and made to run on a special line of rails, laid immediately over the girders which were in place; it had an overhang

of jib of 50 ft., and was tested with a load of 12 tons, the weight of each of the main girders being slightly under 10 tons. The girders were put together on the abutment and riveted up complete, and were then placed in position by the aid of the crane in a very few hours. In the construction of the main girders channel irons were very extensively used, which for small spans is found to be very economical, on account of the small quantity of riveting entailed. The cross-girders and rail-bearers are of iron, the former resting on turned steel pins, carried by steel castings on saddles, bridging the top boom of the main girders. Provision was made at one end of each main girder for expansion and contraction, as also in the wrought-iron rail bearers. One of the spans of each class was very severely tested before leaving England, and the results obtained were remarkably good. The section of the columns consists of four rolled pillar iron sections, and four bars of 3½ in. × ¼ in. The method of joining the columns is very simple, and has been found to be most effective. It consists of an internal diaphragm of cruciform section, built up of three plates and four angle irons. These junction pieces were sent out riveted in place at the upper end of each column, thus forming a base or spigot for the following length of column to be placed upon or over.

The diaphragm junction pieces are each 4 ft. 8 in. long, the plates used in their construction being ¾ in. thick. The 3½ in. × ¼ bars are stopped at 2 ft. 4 in. from either end of each column, and the spaces between the flanges of the pillar irons, for this length, are occupied by the plates of the cruciform junctions, which plates are extended beyond the width of the column where necessary, and thus form wings or lugs, to which the main bracing of the pier is attached. All the tie-bars, excepting the horizontal ones, are in pairs, and this was found to give much facility for the erectors to get about the work. All tie-bars are fitted with muff coupling boxes, so that they can be adjusted to the exact length required. It was a condition of the contract that a special hydraulic press should be provided by the contractors, capable of testing a length of column of 30 ft. 6 in. to destruction.

The results obtained from the tests made on two columns were remarkably satisfactory and uniform, there being practically no difference between the two. In one case the pressure was applied direct to the column section, and in the other to the junction diaphragm. In this latter case it was arranged that the whole of the pressure was conveyed to the column through the rivets connecting the diaphragm at one end, and transmitted through the bolts connecting the diaphragm at the other, the object being to prove the sufficiency of the connections. The general results obtained were as follows: With a load of 600 tons, no measurable permanent distortion was obtained; with a load of 625 tons, a slight permanent deflection from the straight line resulted; and with a load of 650 tons, the column was crippled. The gross section of the columns tested was:

Four pillar irons, each 7.5 square inches...	Sq. in. 30.0
Four bars, 3½ × ¼	10.5
Total gross section.....	40.5

It will thus be seen that these columns withstood, without permanent distortion, a stress of 14.8 tons per square inch of gross section; a remarkable result, seeing that the greatest diameter of the column—measured over the flanges—is one-eighth of its length. After the two columns were tested as above described, they were further subjected to a falling weight test to prove the resisting power of the material to sudden impact.

The contract for the viaduct was secured by the Horseley Company, of Tipton, Staffordshire, and the firm executed the work to Mr. Woods's entire satisfaction, the materials employed, all of which had to stand most severe tests, and the quality of the workmanship throughout being of the highest class. Each pier was temporarily put together and laid upon a level platform in the bridge-yard, with all cross-bracing, struts and ties in place, and then carefully checked as to dimensions. The Horseley Company undertook to send two skilled men out to Bolivia to superintend the erection, and their choice fell upon Mr.

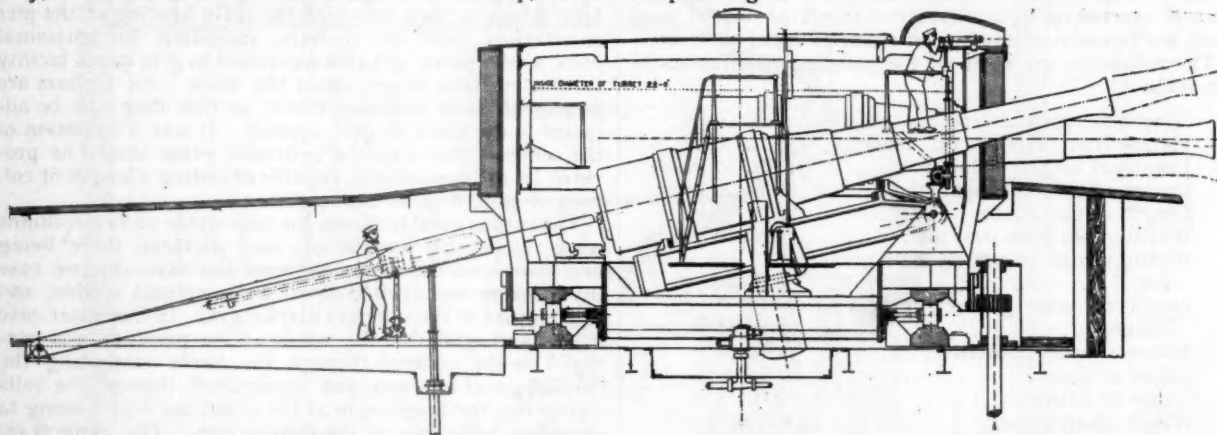
Peter Fisher, as principal, and Mr. William Fisher, his brother, as assistant. How carefully the work had been executed here, and how good a choice the contractors made in their representatives, is shown by the following facts.

Before the work of erecting was commenced Mr. Harding had given up his position in Bolivia, and Mr. Peter Fisher had therefore to take the responsibility of the erection. He commenced rigging up tackle in Bolivia on May 2, 1887, the viaduct was finished on January 28 following, and the first train was run across on February 16, 1888. The above result was accomplished without the assistance of any skilled labor, as the only men available were such as could be picked up at the port of Antofogasta. They were mostly sailors, without any previous knowledge of iron construction. Not only was the viaduct erected within the comparatively short time of rather over nine months, but it is a satisfaction to all concerned that it was completed without loss of life or serious accident. The number of men employed upon the work averaged 35 to 40, the greatest number at any one time being 55. Trains run over the viaduct at speeds of about 30 miles per hour as a maximum.

HYDRAULIC ENGINE FOR LOADING GUNS.

(From the *London Engineer*.)

THE *Edinburgh*, one of the later ships of the English Navy, is a first-class twin-screw turret battle-ship, with



armored citadel, but with ends unprotected except by a steel deck covering the magazines, engines, and other vitals.

This ship and the *Colossus* are precisely similar, the principal dimensions and other characteristics being as follows: Length, 325 ft.; beam, 68 ft.; extreme draft, 26 ft. 3 in.; displacement, 9,150 tons; both were completed in 1886; the engines of the *Edinburgh* were turned out by Humphreys, those of the *Colossus* by Maudslay; indicated H. P., 7,500; speed, as tested on measured mile, 16 knots. The cost of the hull and machinery was about £645,000 in each case; the coal capacity, 970 tons, sufficient for 6,200 miles at 10 knots.

The *Edinburgh* has a metacentric height of 9 ft.; the duration of rolling oscillations, in fighting condition, being nine seconds, the steadiness of the vessel having been very much increased by bilge keels. When the highest steam pressure was put on it reached 64½ lbs. to the square inch. With this there was very little vibration of the ship, but a considerable wave was thrown up in front of the bows. This is, however, the case with even the very lightest of our swift unarmored cruisers when driven at full speed, and in the more recent examples a water run is constructed diagonally across the fore-castle deck, to conduct the combs of the waves over the sides when they break on board. The draft from all the furnaces, being concentrated, in both of these vessels, through a single funnel, the heat generated at full speed is excessive, and it was found in the *Edinburgh* that the deck got burned in the vicinity of the funnel casing.

The armor of these vessels is disposed of as follows: Upon the sides of the citadel, which are 18 in. at the thickest part; upon the bulkheads 16 in. and 13 in.; and upon the turrets 16 in. and 14 in. There is also a teak backing from 10 in. to 22 in. The turrets are placed diagonally, so as to present, simultaneously, a broadside or an end-on fire. The upper works generally, and the upper batteries, are unprotected by armor plates. This is of course the serious blot in the construction of nearly all our modern battle-ships, in view of the effects of high explosives; but it will be remedied in future, as the secondary batteries are to be plated with 3-in. armor.

The armament consists of four 12-in., 47-ton breech-loading rifled steel guns; five 6-in. breech-loading steel guns, and 22 quick-firing and machine guns; also torpedo tubes. The engraving herewith gives a section of the turret and gun mountings for two of the 12-in. guns, which will penetrate 21 in. of armor plate.

The turret revolves on a roller path laid on the main or citadel deck, and its base is, in consequence, protected by the armor surrounding the citadel. It is turned by a pair of hydraulic engines placed on the deck beneath, and geared to the turret by vertical shafts and toothed wheels engaging with a rack carried near the bottom of the mounting. A special device is used to avoid any lash of the toothed wheels. These engines are controlled by a spindle passing through the axis of the piping at the center of the turret. This spindle is worked by a train of gear from either of the sighting stations; but these and other minor fittings are omitted in the engraving to avoid unduly complicating it.

The guns are loaded from the long boxes shown in the figure; and these are hinged at their rear ends to a pivot attached to the battery deck. In their normal condition they lie flush with the deck, and therefore offer no obstruction to the passage-way. They can be charged either from above or from below, as may best suit other arrangements in the ship, and, after charging, are hoisted by the hydraulic cylinder, shown under the front end, into line with the elevated guns, whenever it is desired to load them. Each box contains an hydraulic rammer, which can be used to push the charge into the gun, after it has been brought into position.

The *Edinburgh* and *Colossus* have both given great satisfaction, as good sea boats and for comfort in heavy weather. They present a steady platform for service of their guns.

THE NEW ENGLISH BATTLE-SHIPS.

THE English Admiralty purposes building eight new battle-ships of the first class, and the designs adopted for them are described in a paper recently read before the Institution of Naval Architects by Mr. W. H. White, Director of Naval Construction.

There are two designs for these ships, the Turret and the Barbette type. The following principles were laid down for the new designs:

1. That there should be four heavy guns placed in two protected stations, situated at a considerable distance apart, each pair of guns having an arc of training of about

260°, equally divided on each side of the line of keel. All four of these guns to be available on each broadside.

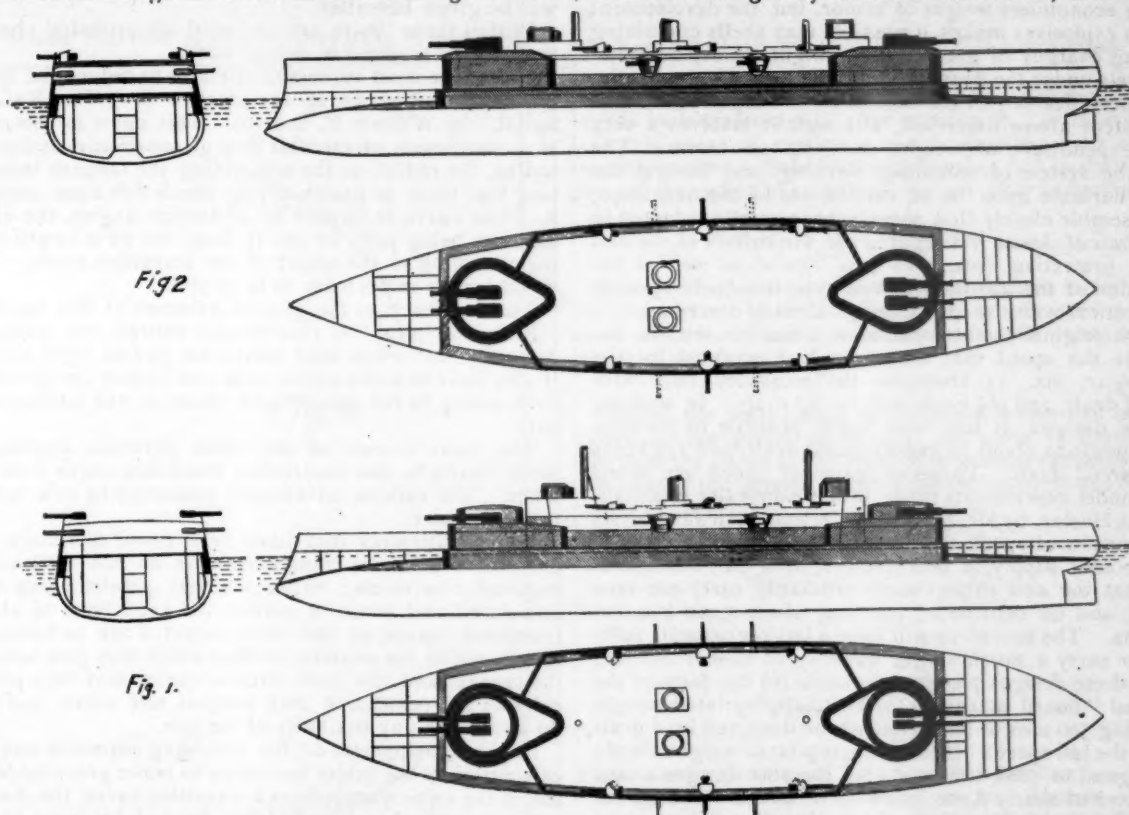
2. That the greater portion of the auxiliary (or secondary) armament should be placed in a long central battery, situated between the two heavy gun stations, and so disposed that there should be practically no interference with the fire of any one gun by that of any other.

3. That in view of the development of high explosives, it was desirable to secure the widest possible distribution of the guns in the auxiliary armament; and that it was preferable to mount the auxiliary armament on two decks, one of them being the spar deck, rather than to carry the guns chiefly between decks.

Each ship is to carry four 67-ton, 13½-in. guns as the principal armament, with hydraulic apparatus for training, elevating, and loading the guns. The auxiliary armament will include ten 6-in. guns, carrying 100-lbs. projectiles and a number of smaller rapid-fire guns.

The *Turret Design* is shown in outline in fig. 1. The

protective deck were flooded, very small "sinkage" and very moderate "change of trim" would ensue. The maximum thickness of the belt armor is 18 in., as against a maximum of 20 in. in the *Trafalgar*; the minimum thickness at the ends of the belt is the same as in the *Trafalgar*—14 in. The proportion of the length protected by the belt is the same in both cases. Above this thick armor belt and protective deck, the broadside is armored with 5-in. steel for a length of 145 ft., and to the height of the upper deck amidships (9½ ft. above water). Oblique armored bulkheads or screens extend across the protective deck, and meet the redoubt armor; thus completely enclosing a lightly armored citadel with its top at the level of the upper deck (9½ ft. above water), having the same extreme length as the central battery, viz., 170 ft. Within the 5-in. steel armor on the sides, coal bunkers are built, extending from the belt to the upper deck, and having an athwartship thickness of 10½ ft. When filled with coal, these bunkers would greatly reinforce the defence; when empty,



armor protection of the hull proper includes two principal features:

1. A belt, 8½ ft. broad, extending over two-thirds the length of the vessel, and having a maximum thickness of 18-in. armor. Transverse armored bulkheads complete the belt, a 3-in. steel deck is fitted above it, and a strong protective under-water deck completes the protection before and abaft the belt.

2. The broadside above the thick belt is protected, to a height of about 9½ ft. above water over a considerable portion of the length, by 5-in. armor. Screen bulkheads, similarly armored, enclose the central battery. The protection of the heavy guns consists of 18 in. armor on the turrets, and 17-in. on the redoubts protecting the turret bases, etc.

The illustrations in fig. 1 will make this description clearer. It will be seen that each turret stands in a separate battery or redoubt, which rests upon the protective deck, and is strongly armored for the defence of the turret bases and loading apparatus. This system has been previously carried out in the *Victoria* and *Sans Pareil*, in each of which there is only one turret. The belt armor rises 3 ft. above water, and extends 5½ ft. below water. Its longitudinal extent is sufficient to insure that if the spaces before and abaft it and above the under water pro-

tection of the hull proper includes two principal features: the minimum defence is 5 in. of steel, which is proof against all the smaller kinds of quick-firing guns, and against many of the most destructive forms of attack from much larger guns. In the new turret ship it has been necessary to provide a long central battery (about 170 ft. in extreme length) to accommodate the more numerous and powerful guns in the auxiliary armament; and the turrets are placed about 200 ft. apart.

The *Barbette Type* is shown in fig. 2. In this design the freeboard at the ends is increased to 18 ft., or 6½ ft. more than the freeboard in the turret ship, and about 7 ft. 4 in. more than in the *Trafalgar* as completed. The heavy guns are carried 23 ft. above water, as against 17 ft. in the new turret ship, and about 15 ft. as designed, or 14 ft. as completed, in the *Trafalgar*. In the English Navy a very large proportion of most recent and powerful ships are of moderate freeboard, carrying their guns only 12 ft. to 14 ft. above water; whereas in foreign navies, in recent years, the heavy guns are chiefly carried from 22 ft. to 28 ft. above water, and the freeboard is high. The decision of the Admiralty to largely adopt the barbette design is avowedly based on these facts, and arrived at with a full knowledge of the relative advantages and disadvantages of the turret and barbette systems, after considering designs for turret ships with guns placed at equal height

above water, and with the same freeboard as the barbette ship. It will be obvious that the increase in height of freeboard and of guns above water can only be secured by means of additional hull weights, and rearrangements of the armor. What has been done is this: The turrets have been abolished, and the weight of armor, etc., is utilized in adding to the height of the redoubts in which the turret bases stand. The barbettes thus formed are strongly armored from the 3-in. protective deck above the belt upward, and are divided into two stories. In the upper story stand the turn-tables carrying the heavy guns, in the lower story will be placed the turning engines and other important portions of the equipment. In most barbette ships hitherto built, whether English or foreign, the barbettes have been shallow armored cylinders, with plated bottoms, standing on light steel structures at a considerable height above the belt deck. Armored tubes have been fitted to protect the ammunition when it is passed up from the magazines into the barbettes. This system greatly economizes weight of armor, but the development of high explosives makes it possible that shells containing bursting charges of great energy might be exploded immediately under the floors of the barbettes. Consequently, it has been decided in the new ships to adopt the alternative system above described, although it involves a very large expenditure of weight and cost on armor. The hydraulic system of mounting, working, and loading the 67-ton barbette guns, to be carried out in the new ships, will resemble closely that already successfully adopted in the *Admiral* class. As regards the disposition of the belt armor, protective deck, and 5-in. armor, as well as the protection of the auxiliary armaments, the barbette ships are identical with the turret design already described.

It was originally contemplated to adhere in the new designs to the speed that had been first accepted for the *Trafalgar*, viz., 15 knots on the measured mile with natural draft, and $16\frac{1}{2}$ knots with forced draft. In working out the designs, it has been found possible to increase these speeds to about 16 knots natural draft, and $17\frac{1}{2}$ knots with forced draft. These estimates of speed are based upon model experiments made in the Admiralty establishment at Haslar, by Mr. R. E. Froude, and upon an analysis of the results of speed trials of recent ships.

As to coal supply, it was decided, after full consideration, that the new ships should ordinarily carry 900 tons of coal, and be capable of covering about 5,000 knots at 10 knots. The new ships will have a bunker capacity sufficient to carry a much larger quantity of coal if desired, and in these designs provision is made (in the form of the so-called "board margin") for an unappropriated weight exceeding 500 tons to be carried at the designed load draft and at the full speed. If the unappropriated weight should be assigned to coal, it would give the new designs a coal endurance of nearly 8,000 knots at 10 knots. Apart from any such increase in coal, however, the 900 tons proposed is a very large supply in relation to expenditure; larger, in fact, than that of nearly all first class battle-ships. At the highest speed contemplated for smooth water, continuous steaming—about 16 knots—the new ships could cover about 1,900 knots.

These new ships will be of about 14,000 tons displacement, and will be among the heaviest fighting ships afloat. Their designs have called out severe criticism, especially from those who do not believe in the usefulness of such very large, unwieldy, and costly vessels.

TRANSITION CURVES.

BY CHARLES DAVIS JAMESON, C.E.

(Continued from page 238.)

WE will now pass to the development of a Transition Curve that shall comply with all the requirements, both theoretical and practical.

1. It commences with a radius of infinity. The radius decreases until it becomes equal to the radius of the circular curve, at which point it is tangent to the circular curve.

2. The length of the radius at any point is inversely proportional to the distance of the point from the starting-

point. (This is only true within narrow limits with the following transition curve. The advantages of a departure from this rule will be explained):

3. The length of offset between the original tangent and the main circular curve can be varied at will within certain limits, thus rendering the line flexible and elastic.

4. The work required in the field in running in these transition curves is no more than that required on the ordinary circular curve, and this, taken in connection with the acquired flexibility of the line, reduces amazingly the total amount of field work necessary to fit the line to the configuration of the ground.

In order to vary the lengths of the offset, the only change necessary is in the length and rate of change of direction in the transition curve; that is, for every change in the length of offset there must be used a different transition curve. This has led to the calculating or tabulating of 12 different curves for each degree and half-degree of change in the radius of the main circular curve. These tables will be given hereafter.

Within these limits are included all probable changes that will be required in actual work.

One of the most successful attempts to reduce the theory of the transition curve to practice is "The Railroad Spiral," by William H. Searles. This curve is composed of a succession of circular arcs of constantly decreasing radius, the radius of the one joining the tangent being so long that there is practically no shock felt upon entering it. The curve is located by deflection angles, the chord used not being 50 ft. or 100 ft. long, but of a length varying according to the length of the transition curve. This chord-length varies from 10 ft. to 50 ft.

The drawback to the general adoption of this so-called "Railroad Spiral" is that it lacks entirely the feature of flexibility, and when used leaves the line as rigid as ever. It also lacks to some extent ease and facility for use in the field, owing to the number and extent of the tables necessary.

The curve known as the cubic parabola approaches more nearly to the theoretical transition curve than any other. The various advantages possessed by this will be taken up later.

The few attempts that have been made to reduce this curve to a practical transition curve do not fulfil all the required conditions; either a single parabola has been calculated and made to answer the conditions of all the transition curves, or the curves selected are so limited in length and in the amount of offset which they give between the tangent and the main circular curve, that they practically fix the position of both tangent and curve, and thus do away with any flexibility of the line.

In the development of the following formulas and the calculation of the tables necessary to make practicable the use of the cubic parabola as a transition curve, the Author takes pleasure in acknowledging his indebtedness to Mr. E. W. Crellin, of the Junior Class, Engineering Department, State University of Iowa.

The equation of the cubic parabola referred to rectangular axis may be written:

$$x^3 = cy. \quad (4)$$

In this c is a constant for any given parabola. Differentiating this equation, we obtain:

$$\frac{dy}{dx} = \frac{3x^2}{c}, \quad (5)$$

which gives the tangent of the angle which the curve at any point makes with the axis x . In the above equation, let $x = 0$, and we have

$$\frac{dy}{dx} = 0.$$

That is, the tangent of the angle which the curve at the origin of the axis makes with the axis x is equal to 0. Consequently, the angle is equal to 0, and the curve at that point is tangent to the axis of x .

We now derive the formula giving the radius of curvature at any point of the cubic parabola. The following is the general formula for the radius of curvature of any curve:

$$R = \frac{\left(1 + \frac{dy^2}{dx^2}\right)^{\frac{3}{2}}}{\frac{d^3y}{dx^3}} \quad (6)$$

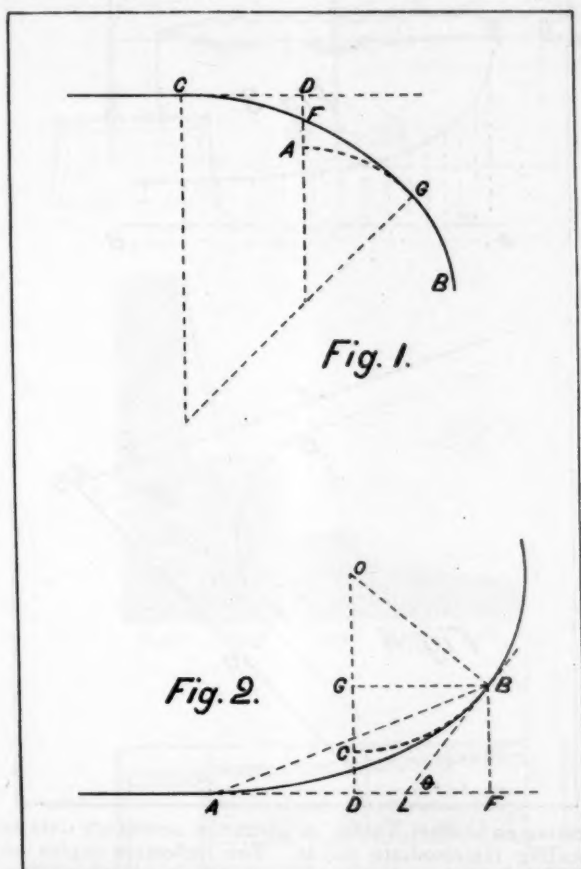
R is the length of the radius at any point. Taking the first and second differential coefficients of the equation $x^3 = cy$, and substituting in this formula, we obtain:

$$R = \frac{(c^2 + 9x^4)^{\frac{3}{2}}}{6c^2x} \quad (7)$$

By assuming values for c and then substituting various values for x , the corresponding radii of curvature are obtained. If we make x equal 0, R becomes ∞ , showing that the curve is tangent to the axis of x , with a radius of infinity. If we neglect the term of the numerator containing x (since it will always be small in comparison with c), we have:

$$R = \frac{c}{6x} \quad (8)$$

which shows that the radius of curvature is nearly in-



versely as the length of the curve from starting-point, measured along the axis.

We thus have two of the properties of the perfect transition curve.

1. The radius at starting from the tangent is infinity.
2. The radius gradually decreases, varying nearly inversely as the distance from the origin. The fact that in the above demonstration we have assumed that the length of the curve is equal to the abscissa will make no material difference in the equation.

To be more exact, the rate of change becomes a little less the farther it recedes from the origin. This slight variation of the cubic parabola from the rule that the radius of curvature should vary inversely as the length is rather an advantage, for the reason that, as the curve approaches this point of contact with the circular curve, the curvature is becoming sharper and a slight decrease in the rate of change is advisable. Thus, if a curve were changing at the rate of one degree of curvature per station near the tangent, it would change at the rate of 50 min-

utes per station near its union with the circular arc. This is one of the advantages of the cubic parabola, the merits of which are taken up later in regard to the superelevation of the outside rail. It does not become apparent unless a considerable portion of the curve is considered. None of the spirals that have been employed for transition curves have such a property. The rate of their change is a constant from the point of tangent to the point of curve.

Obtaining the differential coefficient of the equation:

$$R = \frac{(c^2 + 9x^4)^{\frac{3}{2}}}{6c^2x} \quad (9)$$

we have:

$$\frac{dR}{dx} = \frac{324c^2x^4(c^2 + 9x^4)^{\frac{1}{2}}}{36c^4x^2} - 6c^2(c^2 + 9x^4)^{\frac{1}{2}} \quad (10)$$

Equating to 0, and solving for x , we have:

$$x = \frac{\sqrt{c}}{2.59} \quad (11)$$

which means that when $x = \frac{\sqrt{c}}{2.59}$, R is a minimum. At

this point the radius of curvature ceases to diminish and begins to increase again after passing it. It is evident that this point of minimum radius fixes the limit of the transition curve. Substituting this value (10) in the equation for the radius of curvature, we get after reduction:

$$R = \frac{(c)^{\frac{3}{2}}(45)^{\frac{1}{2}}c^{\frac{1}{2}}}{6} = 0.5674\sqrt{c} \quad (12)$$

This gives a minimum radius of curvature in terms of the constant c . In the same manner, by eliminating c instead of x we obtain a minimum radius in terms of the length of the curve:

$$R = 1.469x \quad (13)$$

That is, the least radius of curvature which can be obtained by the given parabola is not quite $1\frac{1}{2}$ times the length of the curve to the point of minimum radius.

Applying the general formula for the co-ordinates of the center of curvature:

$$m = x - \frac{\left(1 + \frac{dy^2}{dx^2}\right)\frac{dy}{dx}}{\frac{d^3y}{dx^3}} \quad (14)$$

$$n = y + \frac{1 + \frac{dy^2}{dx^2}}{\frac{d^3y}{dx^3}} \quad (15)$$

we obtain the position of the center of curvature.

In fig. 2 let O be the center of curvature. Then $n = OD$ and $m = AD$. Making the necessary substitutions in the above formula, we find:

$$m = \frac{x}{2} - \frac{9x^3}{2c^{\frac{3}{2}}} \quad (16)$$

$$n = \frac{c^2 + 15x^4}{6cx} \quad (17)$$

The second member of (16) is composed of two terms, the first being one-half the whole length of the line AF ; the second term will always be very small, since x is small in comparison with c . The distance AD , then, will be always a little less than one-half of AF . The offset $CD = OD - OC$. $OD = n$, we have from (17), while $OC = OB$ is the radius of curvature at the termination of the transition curve. Therefore, we have:

$$d = OD - OC = n - R = \frac{c^2 + 15x^4}{6cx} - R \quad (18)$$

where d is the length of the offset CD . Making the necessary substitutions to find the value of d when R is minimum, we find:

$$d = (45)^{\frac{1}{2}}\left(\frac{2}{9} - \frac{1}{6}\left(\frac{6}{5}\right)^{\frac{1}{2}}\right)\sqrt{c} \quad (19)$$

$$d = 0.00812\sqrt{c} \quad (20)$$

The results are expressed in the following table :

c .	Radius.	Length.	d = Offset.
10	179	122	2.6
25	284	193	4.0
50	397	273	5.7
100	567	386	8.1
200	802	546	11.5
500	1268	863	18.1
1000	1792	1220	25.6

From this table it may be seen that for a 7-degree curve, for instance, radius 819 ft., the longest transition curve that can be obtained will be about 550 ft., and the greatest offset about 12 ft.

From the above properties of the cubic parabola it is evident that a single cubic parabola would furnish transition curves for all circular arcs of a greater radius than its minimum radius of curvature. It is necessary, then, to calculate as many parabolas as it is desired to have curves for each arc, and in the following tables* we have selected 12 different parabolas, giving as many different lengths of transition curves and offsets, CD , for each degree of circular curve named. By assuming various values for the constant c , and computing the distances AF , AB , AD , BF , CD , and the angles BAF and BLF corresponding to the various lengths of radius, OB , the tables have been constructed. The angle BLF , as will be noted, is the angle between the original tangent and the angle between the parabola and circular arc at the point where they unite. From (7) (the radius of curvature of the cubic parabola), if there are given the values of c and R the value of x cannot be taken directly, this being an equation of the 12th degree, for which there is no general method of solution. The usual methods of approximation are unsatisfactory on account of their great length, and the following method has been used, which gives results of much greater accuracy than is necessary for the purposes of the transition curve.

Writing (7) in the form of :

$$x = \frac{(c^2 + 9x^4)^{\frac{3}{2}}}{6c^2R} \quad (22)$$

x will always be quite small in comparison with c , and an approximate value of x substituted in the second member of the above equation will give a very accurate value for the same quantity. Take equation (7), give c a constant value, and substitute various values for x . With these values of x and the corresponding values of R so obtained, construct the curve shown in fig. 3, in which the values of R are abscissas and those of x ordinates. By simply laying off on the line AB distances corresponding to the radii of the circular curves of different degrees, and measuring the ordinates, the values of x will be obtained with more or less exactitude, depending upon the care with which the curve has been constructed. By substituting the values of x thus obtained, in the second member of (22), the values of x given in the tables are obtained. These will be found in the column marked "Length along Tangent." The corresponding distances are measured along the curve in chords of 50 ft. The distance AD was obtained from the equation previously given (16). These are the numbers in the column headed "M."

The ordinates BF at the end of the transition curve can be found directly from the equation of the curve (4), y being the required ordinate. The total deflection angle, BAF , is the angle whose tangent is :

$$\frac{y}{x} = \frac{x^2}{c} \quad (23)$$

this last result being obtained from the equation of the parabola.

These angles obtained from a table of tangents are placed in the column headed "Total Deflection." The tangent of the angle which a tangent to a curve at any point makes with the axis of x is equal to the value of the

differential coefficient of the equation of the curve with reference to x , with the co-ordinates of the given point substituted.

In the case of the cubic parabola :

$$\frac{dy}{dx} = \frac{3x^2}{c} \quad (5)$$

which gives the tangent of the angle BLF .

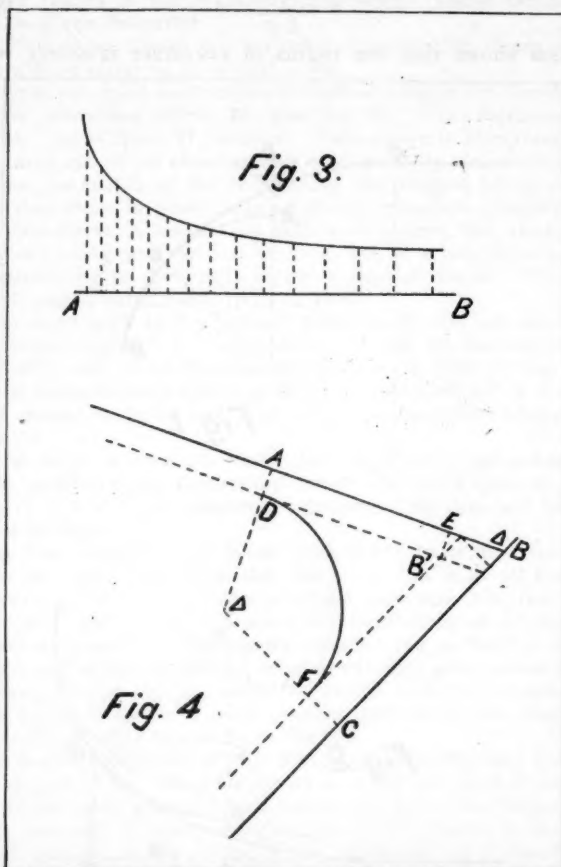
These angles are placed in the column headed "Deflection for Tangent."

The numbers in the column headed "Offset = d " are the distances CD .

From fig. 1.

$$CD = BF - CG = \frac{x^3}{c} - OB \text{ vers. } \theta \quad BOG = \frac{x^3}{c} - R \text{ vers. } \theta, \quad (24)$$

θ = the angle BLF already obtained. From the above equation the values of d have been obtained. In the "De-



flection and Offset Table" is given the necessary data for locating intermediate points. The deflection angles are given for the termination of every 50-ft. chord. Offsets from the tangent are also given every 50 ft., measured along the tangent.

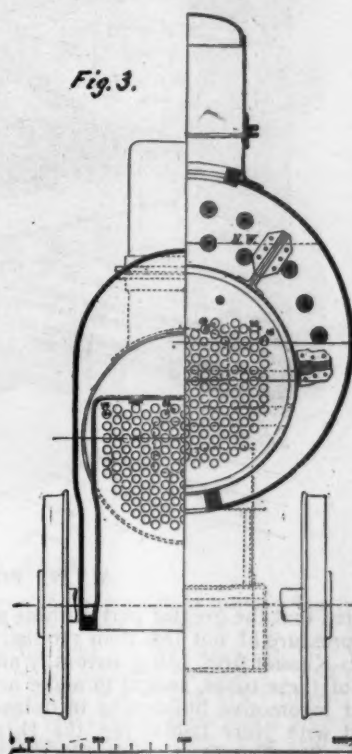
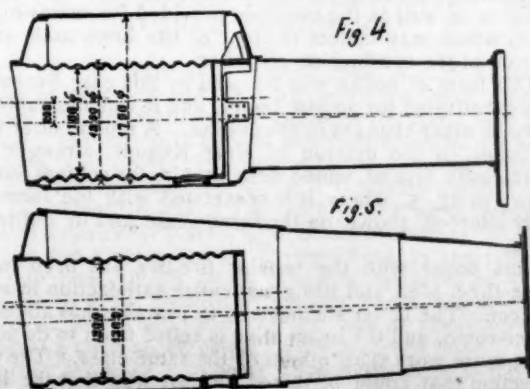
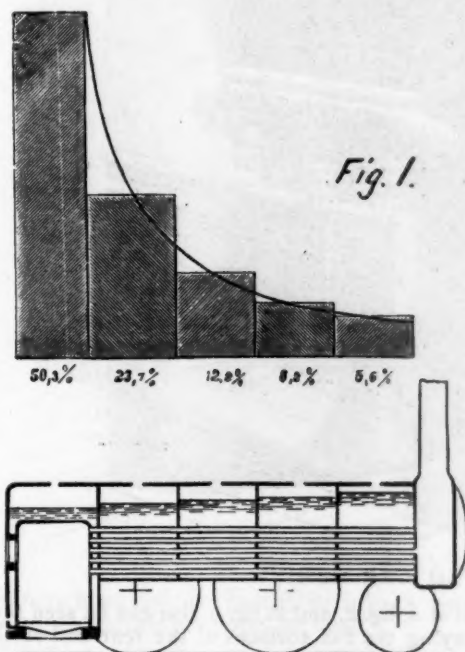
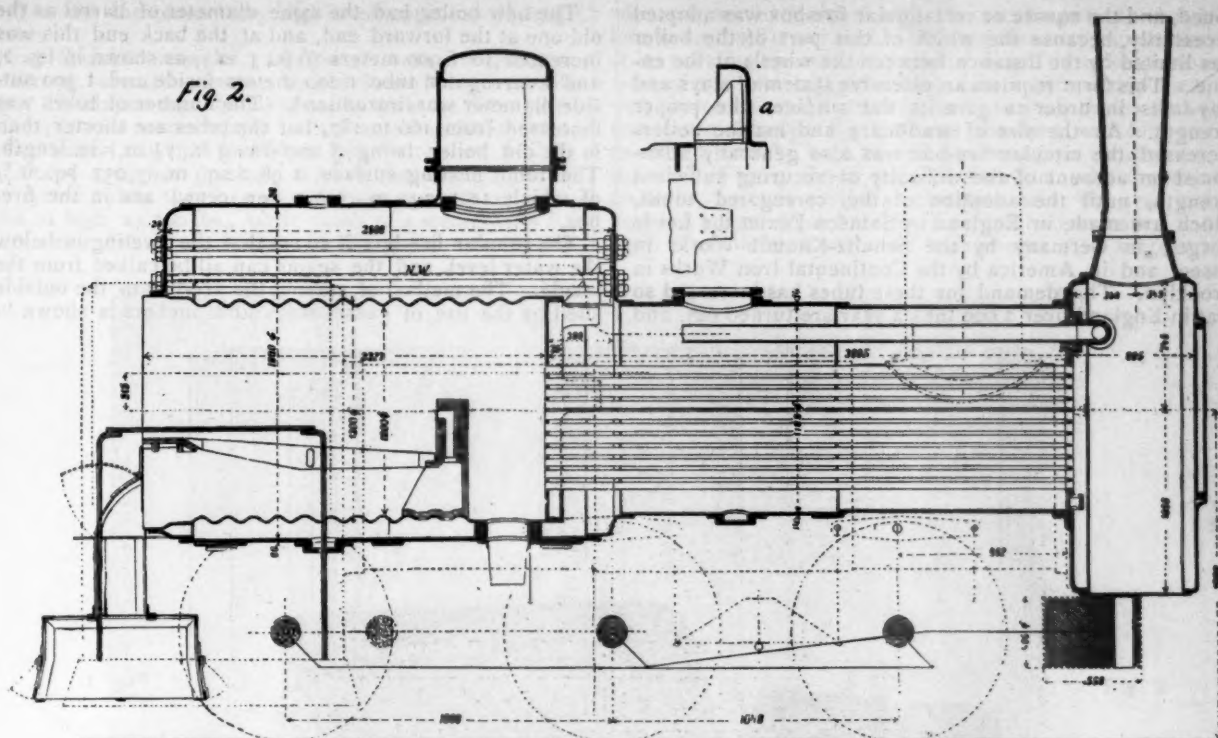
(TO BE CONTINUED.)

CORRUGATED TUBULAR FIRE-BOXES FOR LOCOMOTIVES.

(Condensed from paper read by Herr Otto Kraudt before the German Mechanical Engineers' Union.)

SINCE the first establishment of railroads there has been a constant increase in the size and weight of the motive power. We have already cylinders as large as 24 and even 26 in. in diameter, while the pressure of steam has also been constantly increased until now working pressures of 150 and 180 lbs. are used, and for the better utilization of this high pressure the compound system is on trial. In order to meet these demands boiler-makers have been continually improving their work, but while the size and weight of boilers have been increased, there has been

* The tables here referred to will be given hereafter.



very little change in the general form and arrangement of those used for locomotives.

Careful investigations have, however, been made of the relative value of the heating surface of different parts of the boiler; the accompanying diagram, fig. 1, which was prepared by M. Lencauchez, shows in graphic form the relative value of the heating surface of the fire-box and of different portions of the tubes; the latter are, in the diagram, divided into sections and the relative value of the different sections is expressed by the shaded rectangles. From this diagram the value of an increase of fire-box surface can be readily seen.

As the size of locomotive boilers increased, the cylindrical forms which were at first used were generally aban-

done, and the square or rectangular fire-box was adopted necessarily, because the width of this part of the boiler was limited by the distance between the wheels of the engine. This form requires an extensive system of stays and stay-bolts in order to give its flat surfaces the proper strength. As the size of stationary and marine boilers increased the circular fire-box was also generally abandoned on account of the difficulty of securing sufficient strength, until the adoption of the corrugated tubes, which are made in England by Samson Fox at the Leeds Forge; in Germany by the Schultz-Knaudt Works in Essen, and in America by the Continental Iron Works in Brooklyn. The demand for these tubes has increased so that in England over 3,000 tons a year are turned out, and

The new boiler had the same diameter of barrel as the old one at the forward end, and at the back end this was increased to 1.900 meters (6 ft. 3 in.), as shown in fig. 2, and a corrugated tube 1.200 meters inside and 1.300 outside diameter was introduced. The number of tubes was increased from 160 to 187, but the tubes are shorter than in the old boiler, being 3 meters (9 ft. 7½ in.) in length. The total heating surface is 98.2 sq. m. (1,057 sq. ft.), of which 10.1 sq. m. (10.3 per cent.) are in the fire-box.

The tubular fire-box is so set that the riveting is below the water level, and the seams can all be calked from the inside. The method of staying the fire-box to the outside shell by the use of gusset-stays and anchors is shown in

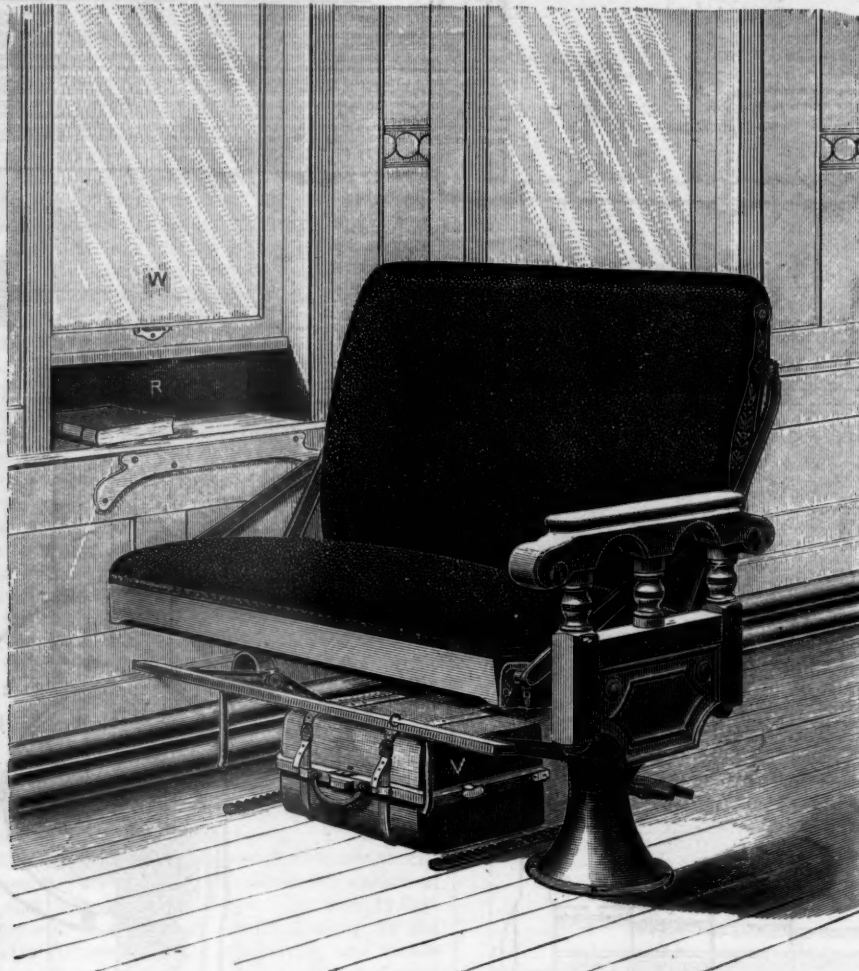


Fig. 1.

M. N. FORNEY'S IMPROVED CAR SEAT.

it is to be noted that the greater part of these are required to stand the pressure of not less than 150 lbs. in practice.

The Schultz-Knaudt firm, being naturally anxious to extend the use of these tubes, sought to make arrangements with different locomotive builders to introduce them, and finally agreed with Herr Pohlmeier, the Director of the State Railroad Shops at Dortmund, Westphalia, to make the experiment. A boiler fitted with the cylindrical fire-box was applied on a freight engine having six coupled drivers, with cylinders 16 in. in diameter and 22 in. stroke. The engine was at the time in the shops for rebuilding, and the old cylinders, frames, and wheels were used, only the boiler being changed. Fig. 2 shows a longitudinal section of the boiler as constructed, the light dotted lines showing the outline of the old boiler and fire-box. Fig. 3 shows on one side a half-section of the new boiler with corrugated fire-box and on the other a half-section of the old boiler.

The old boiler had 160 tubes 4.27 meters (14 ft.) in length and the total heating surface was 95.7 sq. m. (1,030 sq. ft.), of which 6.1 sq. m. (6.4 per cent.) were in the fire-box and the remainder in the tubes.

detail at *a*, fig. 2, and in fig. 2 also can be seen the method of staying the flat surfaces of the rear end of the boiler. The arrangement for carrying the grate-bars and the fire-brick bridge forming a combustion chamber is also shown in fig. 2, as well as the manhole provided for removing the ashes which may collect in front of the brick arch at the bottom of the combustion chamber.

This form of boiler was adopted in this case because it was substituted for an old boiler, and it was desirable not to make other changes in the engine. A much better form of boiler, in the opinion of Herr Knaudt, stronger and more easily braced, would be a circular or conical one, as shown in fig. 5, where it is contrasted with the form actually adopted, shown on the same scale and in outline in fig. 4.

This boiler with the tubular fire-box has been in use since June, 1888, and has given entire satisfaction in every respect. The boiler steams well in practice, has abundant water-room, and the locomotive is relied upon to do somewhat more work than others of the same class. The only objection that could be raised against it is that the large diameter required for the back end would make it neces-

sary to raise the center very high in an engine with large drivers.

Herr Knaudt notes the adoption of these fire-boxes on the Strong locomotive in the United States as a favorable sign. He claims that the plain boiler with the corrugated fire-box can be more cheaply built than the ordinary locomotive boiler, and that it will cost less for repairs, while it will stand a higher pressure. As to the strength of the corrugated tubes they are now in use at working pressures as high as 200 lbs., while tubes of 4 meters (13 ft.) in diameter with pressures of 150 lbs. are constantly em-

ployed, and there is no difficulty in making tubes 2 meters in diameter for the highest pressures yet used.

who are not acquainted with the mechanism of what is known as the Forney seat, a little preliminary explanation of its peculiarities may be needed. Fig. 1 is a perspective view of the seat complete; fig. 2 is a perspective view, with the seat-cushion removed, so as to show the construction more clearly; fig. 4 shows the seat and foot-rest raised up, and the back turned half way over for cleaning the car. Fig. 4 shows an end elevation, with the arm omitted; fig. 5 is a similar elevation, with the seat and foot-rest tipped up and the back turned half way over, and fig. 6 is a front view of the old style of seat. The seat-back

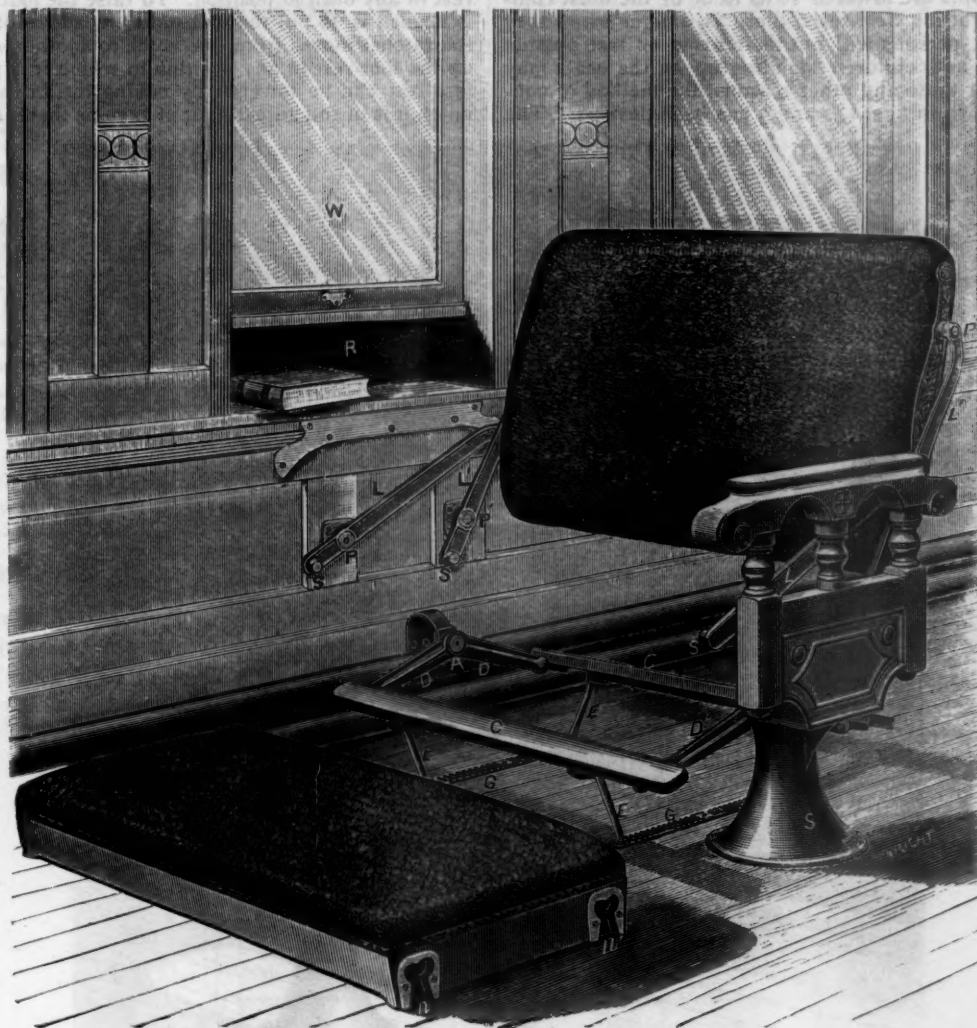


Fig. 2.

M. N. FORNEY'S IMPROVED CAR SEAT.

played, and there is no difficulty in making tubes 2 meters in diameter for the highest pressures yet used.

FORNEY'S IMPROVED CAR SEAT, WITH ADJUSTABLE FOOT-REST.

WITH all car seats as now made there is more or less difficulty in sweeping and cleaning below the seats. The seat itself and the frame which connects the stand next to the aisle of the car, with its side and the foot-rests, are all in the way, and prevent free access to the floor below the seats, and the consequence is that it is always difficult to scrub or sweep the floors thoroughly, and, as a consequence, cars are nearly always imperfectly cleaned. Figs. 1, 2, 3, 4 and 5 represent an improvement in the seats, which are now known by the name of the inventor, the aim of which is to provide a foot-rest whose height can be adjusted, and which, with the seat, can be raised up so as to leave a clear space below for cleaning the floor.

In order to make its construction quite clear to those

who are not acquainted with the mechanism of what is known as the Forney seat, a little preliminary explanation of its peculiarities may be needed. Fig. 1 is a perspective view of the seat complete; fig. 2 is a perspective view, with the seat-cushion removed, so as to show the construction more clearly; fig. 4 shows the seat and foot-rest raised up, and the back turned half way over for cleaning the car. Fig. 4 shows an end elevation, with the arm omitted; fig. 5 is a similar elevation, with the seat and foot-rest tipped up and the back turned half way over, and fig. 6 is a front view of the old style of seat. The seat-back

is reversed from the one position to the other by means of two pairs of crossed links, or arms, $L L'$, fig. 4, one pair at each end of the seat. These are connected to the seat-end and side of car by fixed pivots $P P'$, and to the seat-back by other pivots, $p p'$. The arms project below the fixed pivots $P P'$, and each of them has a projecting pin or stud $s s'$, which support the seat. The seat or cushion-frame has slots $n n'$ in each end which receive the pins $s s'$. These slots allow for the variation in the distance apart of the pins which occurs when the back is reversed. By reversing the back, the seat is moved horizontally; and its inclination is also reversed, so that in both positions of the back it inclines backward, which adds materially to its comfort.

With this mechanism for reversing the backs they can be made of any required height, and, as appears from the illustrations, their lower edges come above the tops of the seats. This leaves the space behind the seat entirely clear, so that with seats of this kind there is more room than with those ordinarily used.

It will also be seen that the fixed pivots P and P' are

located on a line with the top of the seat. With the ordinary method of reversing backs, the seat-arm pivots about which the backs turn must be placed so far above the seats that the arm-rests are elevated at an uncomfortable height, so that the shoulders of passengers are raised up into an uneasy position. The location of the pivots $P P'$, shown in the engravings, permits the arm-rests and window-sills to be lowered to any position that will be most conducive to comfort. The fact that the arms of drawing-room car chairs are always made much lower than those of ordinary car-seats is evidence that the latter are too high. But if the window-sills are lowered so as to be of the most comfortable height for arm-rests, there is danger when they are open that persons will put their arms or feet outside and be hurt, and children standing up on the seats may fall out. For these and other reasons, the method of construction shown in figs. 1, 2 and 3 has been devised. The

connects the stand with the side of the car, may be entirely omitted. The foot-rests C , as shown in fig. 6, have usually been made stationary, and cannot be adjusted to varying heights, and are in the way when the car is cleaned.

In the seat illustrated by the engravings the foot-rests $C C$, fig. 2, are attached to arms $D D$, which are attached to fixed pivots, A , at each end of the seat. The foot-rests can thus turn about those pivots as centers, and will describe the arcs $a b c$, as shown in fig. 5. Pawls $E E$, fig. 2, are attached to the under side of the foot-rest C . These pawls engage in ratchets $G G$ fastened to the floor, and thus hold the foot-rest in any desired position. To raise the foot-rest, all that is needed is to put the foot under it, and as it is raised up the ratchet moves from one notch to another, and will hold up the foot-rest in any position in which it is placed. The foot-rest can be lowered by raising the ratchet out of the notch it is in and adjusting it in any one that is desired. The

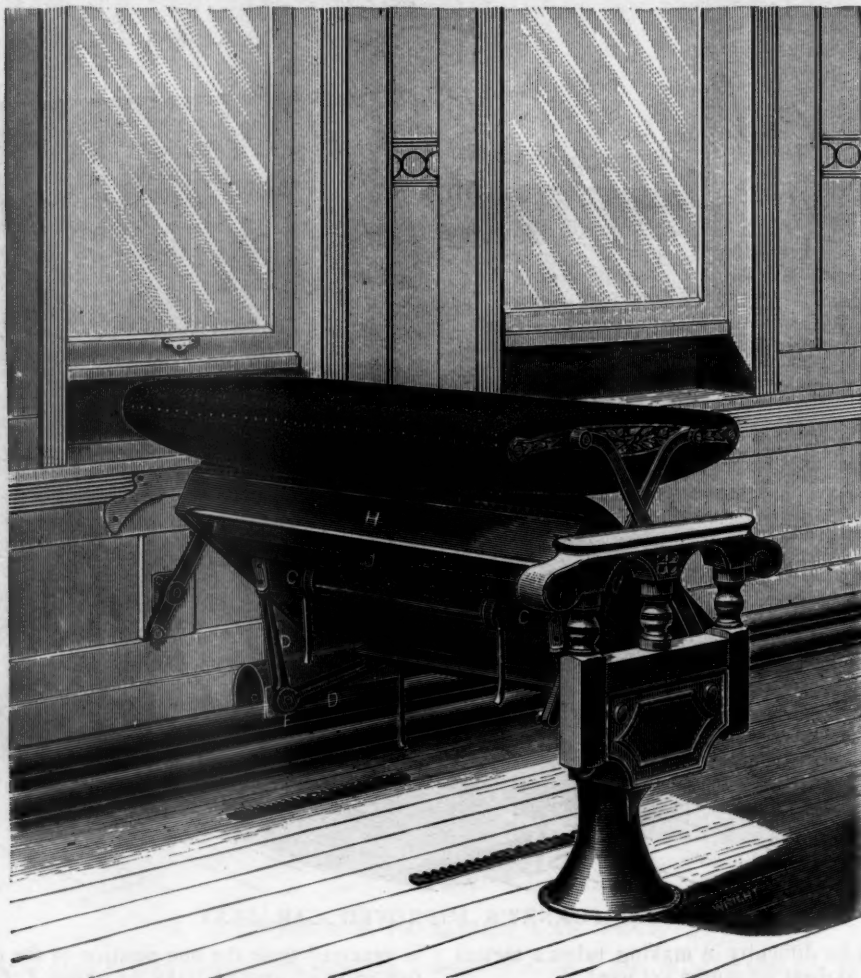


Fig. 3.

M. N. FORNEY'S IMPROVED CAR SEAT.

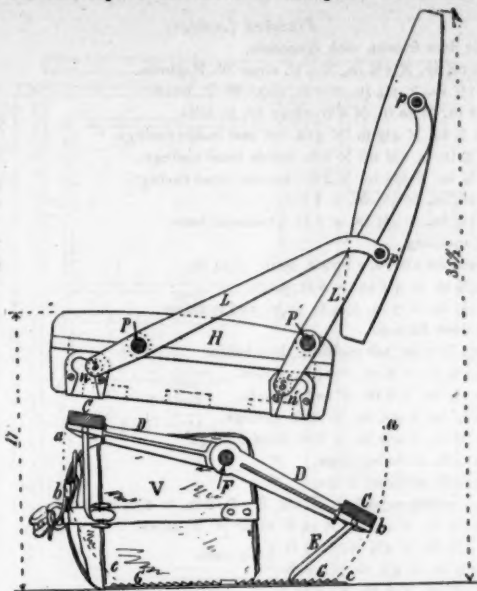
window-ledge has been placed 24 in. above the top of the floor. This is just about the height of a drawing-room car chair-arm. Under the window W , a recess or pocket R is constructed, which is flush with the outside of the car. This makes the ledge wide enough for a comfortable arm-rest, or it can be used as a shelf to hold books or packages.

The special improvement to which attention is called in this article is the construction of the foot-rest and the seat-stand, and the advantages resulting therefrom. Car seats as heretofore made have stands, S , fig. 6, next to the aisle, which are connected to the side of the car by a frame, A , on which the seat usually rests. The only function performed by this frame in the Forney seat has been to give lateral support to the stand. It is obvious that by making the stand, S , fig. 2, of a bell-shape and fastening it securely to the floor that no lateral support would be needed; and as the seat-cushion is supported by the pivots SS' on the ends of the arms $L L'$, that the frame A , of fig. 6, which

two pawls EE on each foot-rest are connected together, so that when one is raised or lowered the other moves with it. As the seat, H , rests on the pivots SS' , it can be turned or tipped up on either pair of them, as shown in figs. 3 and 5. One of the foot-rests can then be turned up into the position shown in the same figures, and it can engage with one of the slats, J , in the under side of the seat, and in this way the foot-rest holds up the seat and the seat holds up the foot-rest; and owing to the absence of a cross-frame under the seat, leaves a clear space for cleaning, as shown in fig. 3. The absence of any cross-frame to the seat also leaves clear space enough below it to receive a valise, as shown in figs. 1 and 4, or other piece of baggage, or package not too large to go below the seat. The foot-rest being movable, permits of its being raised up to put a package below the seat. A receptacle for hats, coats, or other objects could also be attached to the under side of the seat, as is now done in theaters and other public places.

The back of the seat shown in the engravings is 35½ in. high from the top of the floor. The plan of construction

Fig. 4.



illustrated permits of the backs being made of any required height. Each foot-rest can also be made in two parts, so that each occupant of a seat can adjust his or her foot-rest to suit themselves.

Further information about these seats, prices, etc., may be obtained from the Scarritt Furniture Company of St. Louis, Mo., which is manufacturing them, or of M. N. Forney, 145 Broadway, New York.

ENGINEERING UNDER THE EQUATOR.

A CORRESPONDENT, who is at present engaged in making surveys in Siam, writes as follows of the experiences and trials of an engineer in that distant country.

Siam has not got any white elephants, unless the term be employed figuratively, but to one unaccustomed to

principally in the hands of the industrious Chinaman. Outside of Bangkok, of which I have seen little, there are no roads, only villainously bad pack-trails; the rivers are

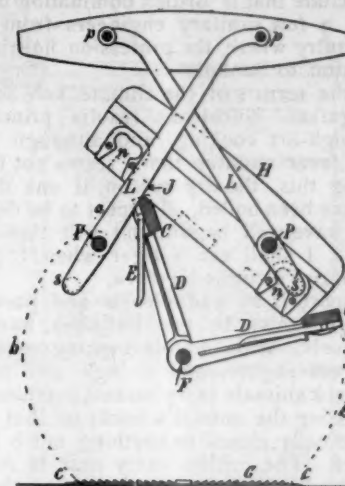


Fig. 5.

the highways of commerce. The country towns are partly afloat on bamboo rafts, and such houses as occupy the land are raised on posts and built haphazard fashion in the timber fringing the stream.

Flat—almost dead-level—valleys, divided by low dikes into little paddy (rice) fields, with bunches of standing timber and countless ant-hills, constitute the most populous district. There is gold—more or less—in the streams, and copper in some of the ranges. The hills are jungle-clad, and my ink is not black enough to paint the character of the jungle. Creepers and thorns make exploring and swearing inseparable. The natives are very ignorant and cowardly; as an instance, the *ghosts* put a stop to my operations until I got from Bangkok a crew of Burmese men, fine fellows, and beautifully tattooed. We speak five languages—one in two distinct dialects—in this camp now, and the only white assistant I have knows none of them but his own. I have picked up Malay myself, which is the common language throughout the Peninsula and Archi-

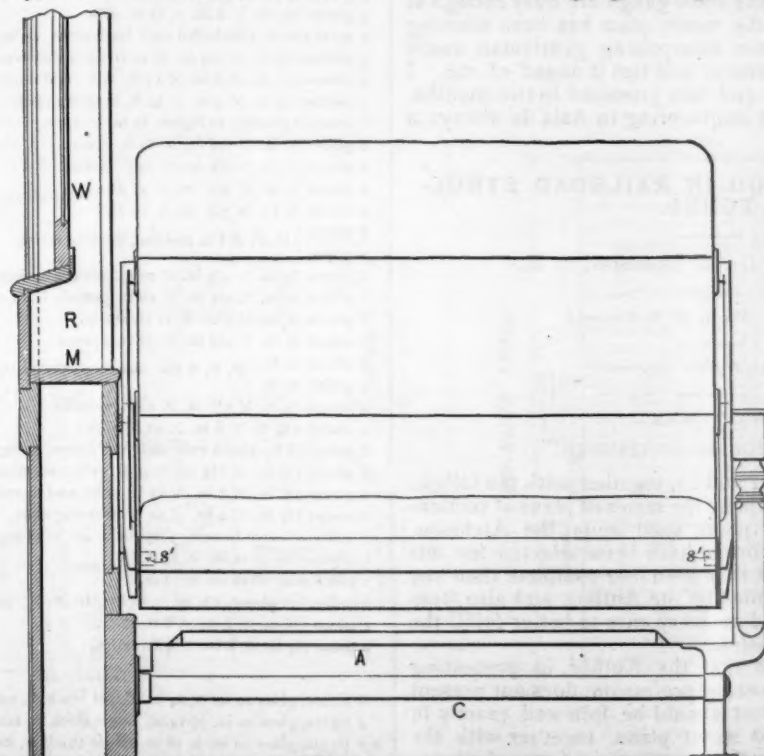


Fig. 6.

Asiatic life there is much that is interesting even without them. The people are a pretty poor lot, and business is

pelago, but Siamese, being a tonal language like Chinese, comes slowly.

"If any one wants to be convinced as to the relative benefits resulting from Christianity and heathenism, let him come to Siam, where Buddhism is in full possession. He may also conclude that if British domination be not desirable, at least a few sanitary engineers from Britain, or any other country where the profession flourishes, would be an acquisition to Bangkok.

As usual, the terrors of the climate fade somewhat on close investigation. Sunstroke results principally from brandy and high-art cooking, and although I am in the heart of the fever country there seems not the slightest danger during this, the dry season, if one drinks water only after it has been boiled. I expect to be detained here till the rains have well begun, and will then use a little quinine daily. I shall see a tiger when I go back to Bangkok, if Charini's circus be there.

Land transport is by paddy-carts and pack-bullocks; the former are drawn by two buffaloes, have a pair of enormous wheels, with double bearings—like a great Western express engine—and a high and very narrow body. The pack animals carry baskets ingeniously pierced by a pole crossing the animal's back, so that the basket mouth is effectually closed to anything much larger than a handkerchief. The coolies carry next to nothing, and on the whole transport is about as hard as on the Canadian Pacific surveys fifteen years ago.

Speaking of the Canadian Pacific, there could hardly be a greater contrast than between the solemn, silent Northern pine forests and this jungle, full of sound from enormous crickets and wailing monkeys; the noise the former make is astonishing. There are plenty of birds, too, but few melodious ones. The crying monkey—if he is a monkey—I have never seen, though we hear them almost daily; but the common fellow, with his long tail and his noisy chatter, frequently appears in the branches overhead, and in a violent passion.

The best man I have is a little Malay-speaking Chinaman, whom I took in Singapore from between the shafts of a rickshaw—a miniature hansom cab, with a man instead of a horse. The Chinaman has one fine quality which raises him away above other Asiatics—he is industrious; and when you get one who adds to that truthfulness and intelligence you are very lucky indeed—in Siam.

Now I must close; I suppose that, in spite of your mild weather up to January, the snow gangs are busy enough at this date—March—and the rotary plow has been winning new honors. I wish some enterprising gentleman would get up a rapid-jungle clearer and test it ahead of me. I have 60 miles to run yet, and rain promised in two months. Don't be persuaded that engineering in Asia is always a picnic.

THE USE OF WOOD IN RAILROAD STRUCTURES.

BY CHARLES DAVIS JAMESON, C. E.

(Copyright, 1889, by M. N. Forney.)

(Continued from page 216.)

CHAPTER IX.

SECTION-HOUSES CONTINUED.

PLATES Nos. 19, 20, 21 and 22, together with the following bills of material, complete the series of plans of section-houses. The standard plans used upon the Atchison, Topeka & Santa Fé Railroad have been selected for this series, from the fact that they are more complete than any other that could be obtained by the Author, and also from the fact that they seemed in every case to better fulfill the requirements of the occasion.

It must be understood that the Author, in presenting these plans to the engineering profession, does not present them as a set of plans that should be followed exactly in every case, but more as a set of plans, together with the bills of material, that shall be suggestions from which engineers can form plans and ideas that shall suit exactly the required conditions in any particular location.

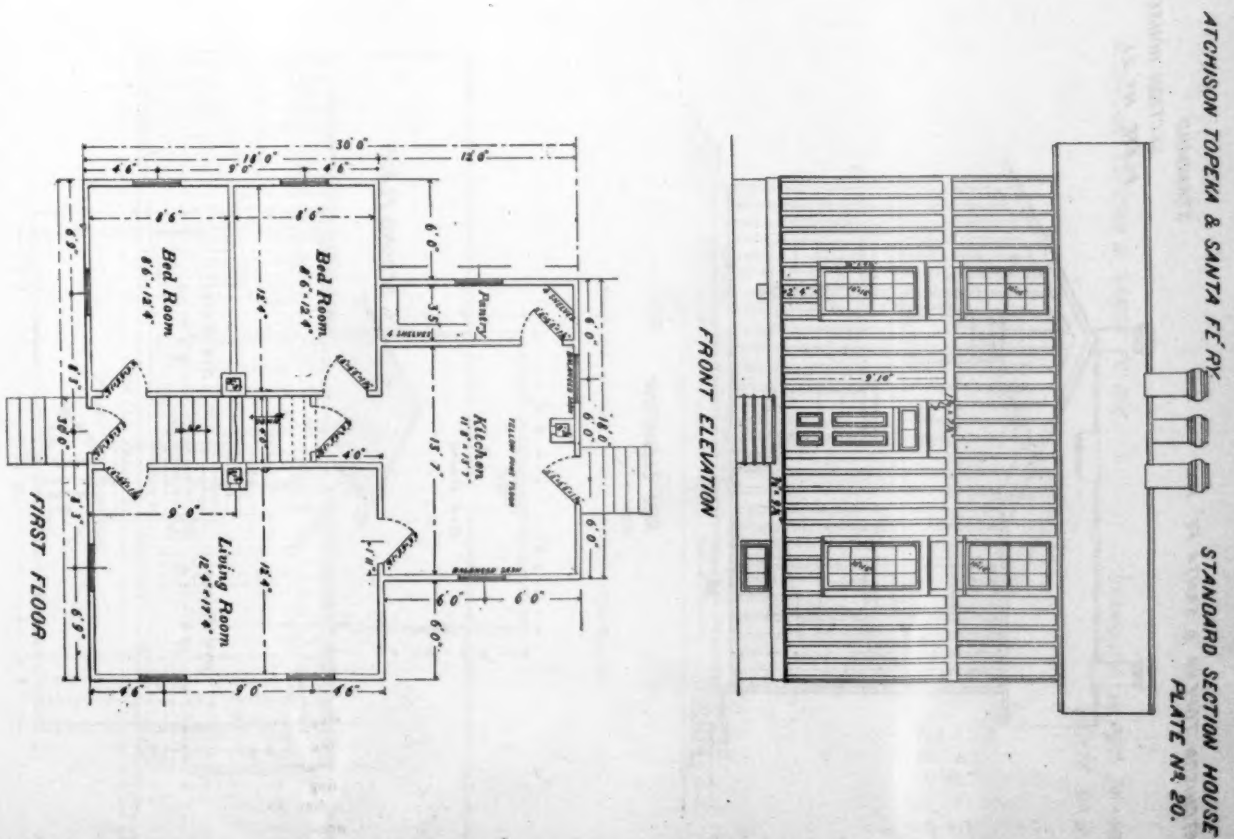
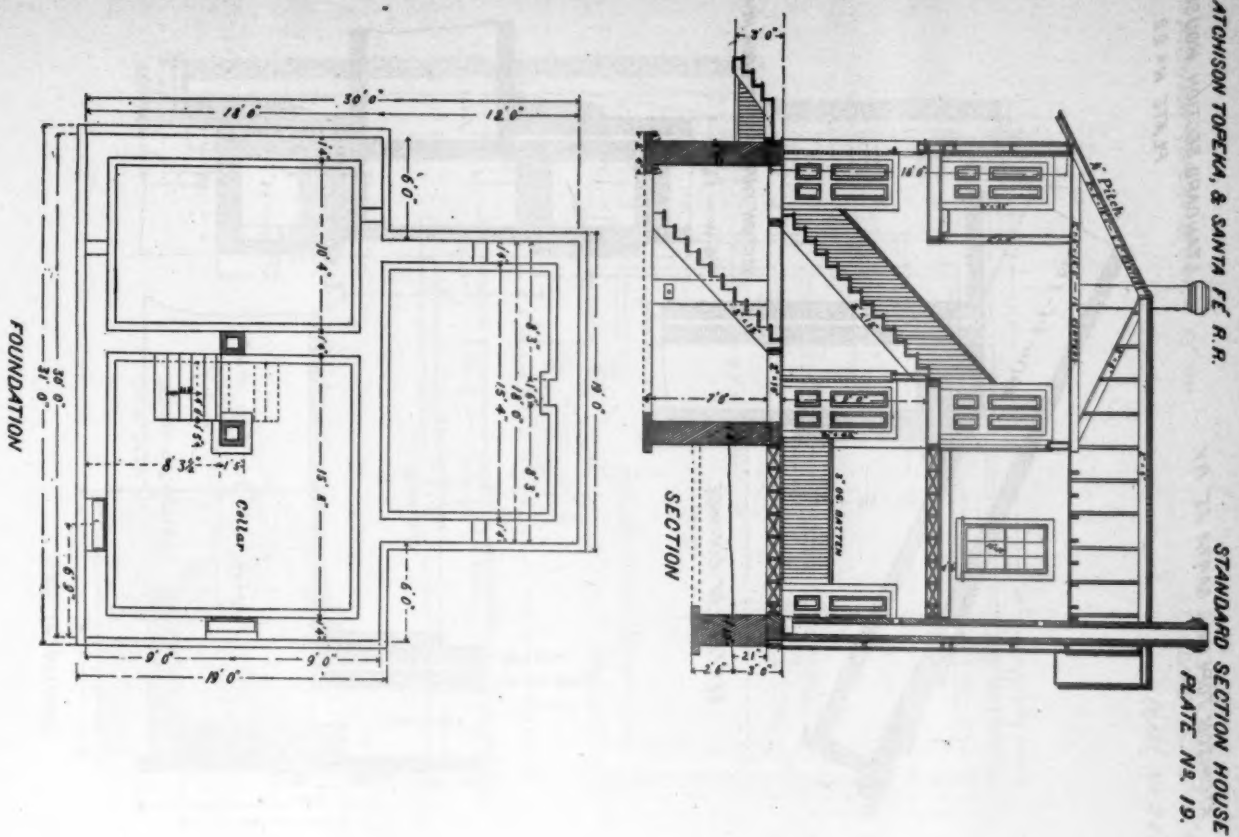
No. 30. BILL OF MATERIAL FOR SECTION-HOUSE. No. 2, ATCHISON, TOPEKA & SANTA FÉ RAILROAD.

Finished Lumber.

- 2 outside door frames with transoms.
- 4 pieces $1\frac{1}{2}$ in. \times $7\frac{1}{2}$ in. \times 9 ft. clear W. P. jambs.
- 1 piece $1\frac{1}{2}$ in. \times $7\frac{1}{2}$ in. \times 7 ft. clear W. P. heads.
- 1 piece 2 in. \times 10 in. \times 8 ft. clear W. P. sills.
- 8 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 9 ft. out and inside casings.
- 1 piece $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 8 ft. inside head casings.
- 1 piece $\frac{3}{4}$ in. \times $6\frac{1}{2}$ in. \times 8 ft. outside head casings.
- 1 piece $2\frac{1}{2}$ in. \times $3\frac{1}{2}$ in. \times 8 ft.
- 1 piece $1\frac{1}{2}$ in. \times $3\frac{1}{2}$ in. \times 8 ft. } transom bars.
- 8 lin. ft. molding.
- 2 transoms for above, 2 lights, 10 in. \times 14 in.
- 1 piece $1\frac{1}{2}$ in. \times $5\frac{1}{2}$ in. \times 6 ft. rails.
- 1 piece $1\frac{1}{2}$ in. \times 7 in. \times 3 ft. stiles and muntins.
- 11 inside door frames.
- 11 pieces 3 ft. 2 in. ash molding thresholds.
- 11 pieces $1\frac{1}{2}$ in. \times 6 in. \times 14 ft. jambs.
- 3 pieces $1\frac{1}{2}$ in. \times 6 in. \times 12 ft. heads.
- 22 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 14 ft. casings.
- 11 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 8 ft. head casings.
- 11 pieces 14 ft. molding stops.
- 3 pieces 12 ft. molding stops.
- 13 doors, 4 panels raised O. G. $1\frac{1}{2}$ \times 2 ft. 8 in. \times 6 ft. 8 in.
- 13 pieces $1\frac{1}{2}$ in. \times $4\frac{1}{2}$ in. \times 14 ft. clear W. P. stiles.
- 3 pieces $1\frac{1}{2}$ in. \times $4\frac{1}{2}$ in. \times 9 ft. } top rails.
- 1 piece $1\frac{1}{2}$ in. \times $4\frac{1}{2}$ in. \times 12 ft.
- 3 pieces $1\frac{1}{2}$ in. \times 8 in. \times 9 ft. } lock rails.
- 1 piece $1\frac{1}{2}$ in. \times 8 in. \times 12 ft.
- 3 pieces $1\frac{1}{2}$ in. \times 10 in. \times 9 ft. } bottom rails.
- 1 piece $1\frac{1}{2}$ in. \times 10 in. \times 12 ft.
- 7 pieces $1\frac{1}{2}$ in. \times $4\frac{1}{2}$ in. \times 14 ft. muntins.
- 7 pieces $\frac{3}{4}$ in. \times 12 in. \times 12 ft. panels.
- 9 window frames, 12 lights, 10 in. \times 16 in., 2 for balanced sashes.
- 9 pieces $\frac{3}{4}$ in. \times $6\frac{1}{2}$ in. \times 13 ft. pulley stiles.
- 3 pieces $\frac{3}{4}$ in. \times $6\frac{1}{2}$ in. \times 10 ft. heads.
- 9 pieces $\frac{3}{4}$ in. \times $1\frac{1}{2}$ in. \times 13 ft. } blind stops.
- 3 pieces $\frac{3}{4}$ in. \times $1\frac{1}{2}$ in. \times 10 ft.
- 9 pieces 12 ft. } P. F. & Co. molding parting strips.
- 3 pieces 10 ft.
- 9 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 13 ft. outside casings.
- 3 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 12 ft. outside head casings.
- 3 pieces $\frac{3}{4}$ in. \times 5 in. \times 13 ft. stools.
- 3 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 12 ft. aprons.
- 12 pieces molding stops.
- 3 pieces $\frac{3}{4}$ in. \times $5\frac{1}{2}$ in. \times 10 ft. subsills.
- 3 pieces $1\frac{1}{2}$ in. \times 6 in. \times 12 ft. sills.
- 9 pairs $1\frac{1}{2}$ in. check-rail sash for frames, 12 lights, 10 \times 16.
- 3 pieces $1\frac{1}{2}$ in. \times $8\frac{1}{2}$ in. \times 10 ft. rails and muntins.
- 9 pieces $1\frac{1}{2}$ in. \times 8 in. \times 13 ft. stiles and muntins.
- 3 pieces $1\frac{1}{2}$ in. \times 4 in. \times 10 ft. meeting rails.
- 6 window frames, 12 lights, 10 in. \times 14 in.
- 6 pieces $\frac{3}{4}$ in. \times $6\frac{1}{2}$ in. \times 11 ft. jambs.
- 2 pieces $\frac{3}{4}$ in. \times $6\frac{1}{2}$ in. \times 10 ft. heads.
- 6 pieces $\frac{3}{4}$ in. \times $1\frac{1}{2}$ in. \times 11 ft. } blind stops.
- 2 pieces $\frac{3}{4}$ in. \times $1\frac{1}{2}$ in. \times 10 ft.
- 6 pieces } P. F. & Co. molding parting strips.
- 2 pieces }
- 6 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 11 ft. outside casings.
- 2 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 10 ft. outside head casings.
- 2 pieces $\frac{3}{4}$ in. \times 5 in. \times 12 ft. stools.
- 2 pieces $\frac{3}{4}$ in. \times $4\frac{1}{2}$ in. \times 12 ft. aprons.
- 6 pieces 12 ft. } P. F. & Co. molding window stops.
- 2 pieces 10 ft.
- 2 pieces $\frac{3}{4}$ in. \times $5\frac{1}{2}$ in. \times 10 ft. subsills.
- 2 pieces $1\frac{1}{2}$ in. \times 6 in. \times 12 ft. sills.
- 6 pairs $1\frac{1}{2}$ in. check-rail sash for frames, 12 lights, 10 \times 14.
- 2 pieces $1\frac{1}{2}$ in. \times $8\frac{1}{2}$ in. \times 10 ft. rails and muntins.
- 6 pieces $1\frac{1}{2}$ in. \times 8 in. \times 12 ft. stiles and muntins.
- 2 pieces $1\frac{1}{2}$ in. \times 4 in. \times 10 ft. meeting rails.
- 2 cellar window frames, 3 lights, 10 in. \times 14 in.
- 1 piece 2 in. \times 10 in. \times 14 ft. } frames.
- 1 piece 2 in. \times 10 in. \times 8 ft.
- 2 sashes for above, $1\frac{1}{2}$ in., 3 lights, 10 in. \times 14 in.
- 1 piece $1\frac{1}{2}$ in. \times 6 in. \times 8 ft. rails.
- 1 piece $1\frac{1}{2}$ in. \times 8 in. \times 4 ft. stiles.

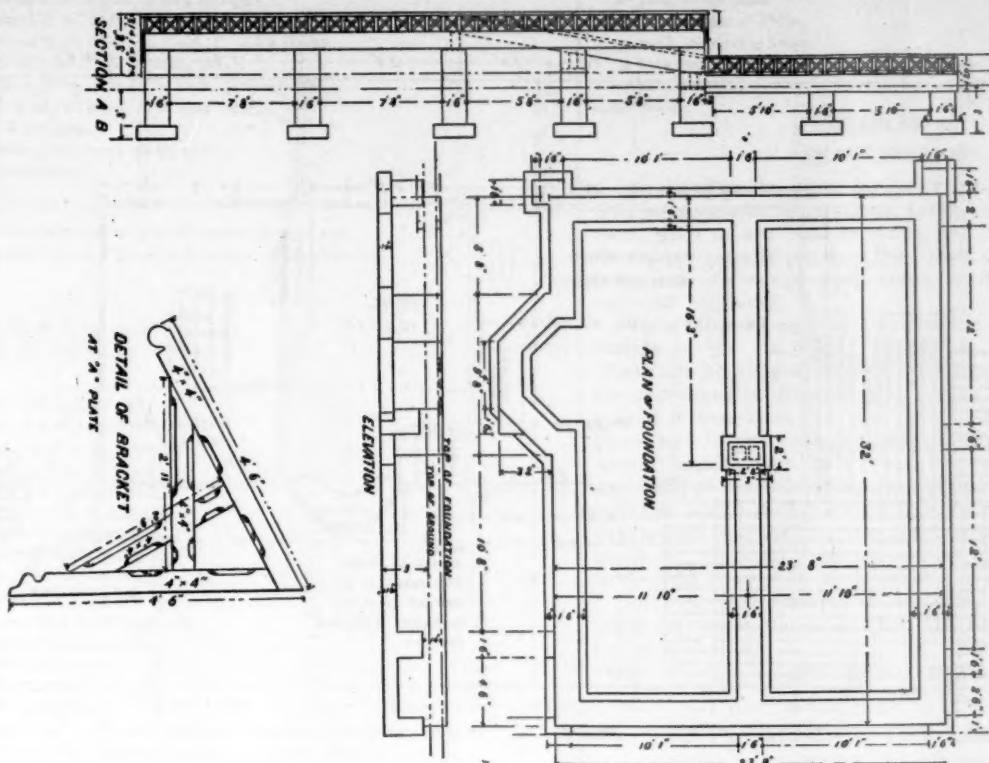
Hardware.

- 6 lights, glass 10 in. \times 14 in. single thick A, cellar windows.
- 4 lights, glass 10 in. \times 14 in. single thick A, transoms.
- 108 lights, glass 10 in. \times 16 in. single thick A, first-story windows.
- 72 lights, glass 10 in. \times 14 in. single thick A, second-story windows.
- 8 pieces 2 in. axle pulleys, kitchen windows.
- 2 gross round-headed $\frac{3}{8}$ -in. wood screws No. 7, window stops.



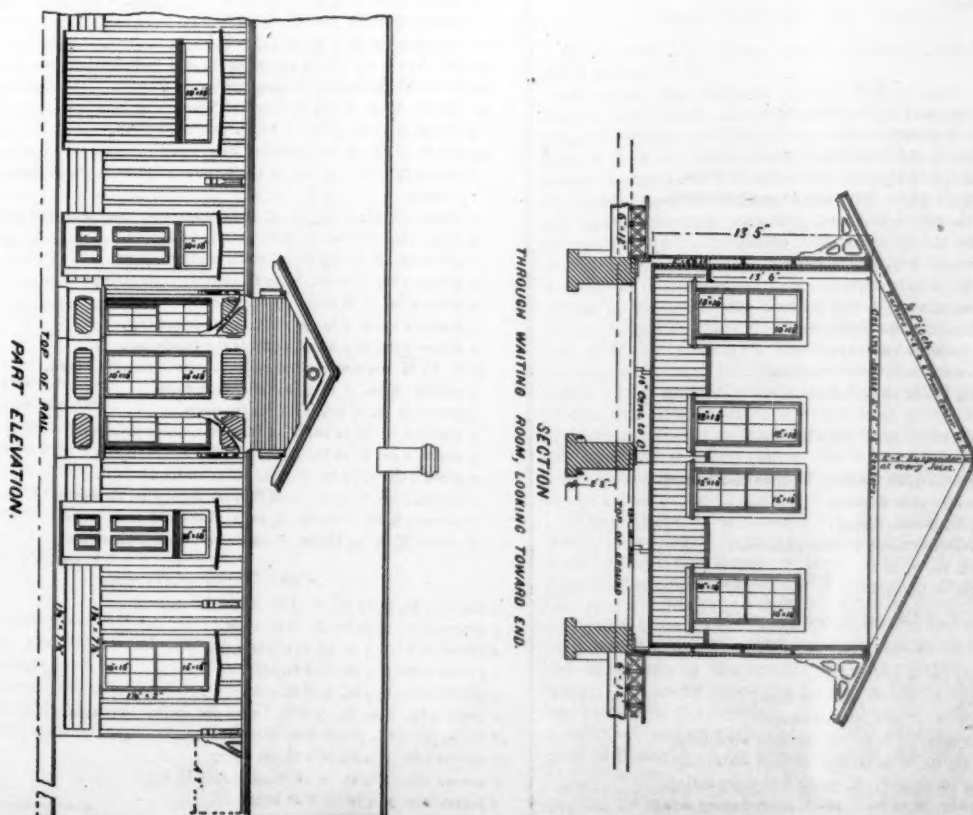
ATOHISON TOPEKA & SANTA FE RY

STANDARD DEPOT, 24'-60"
PLATE NO. 24.



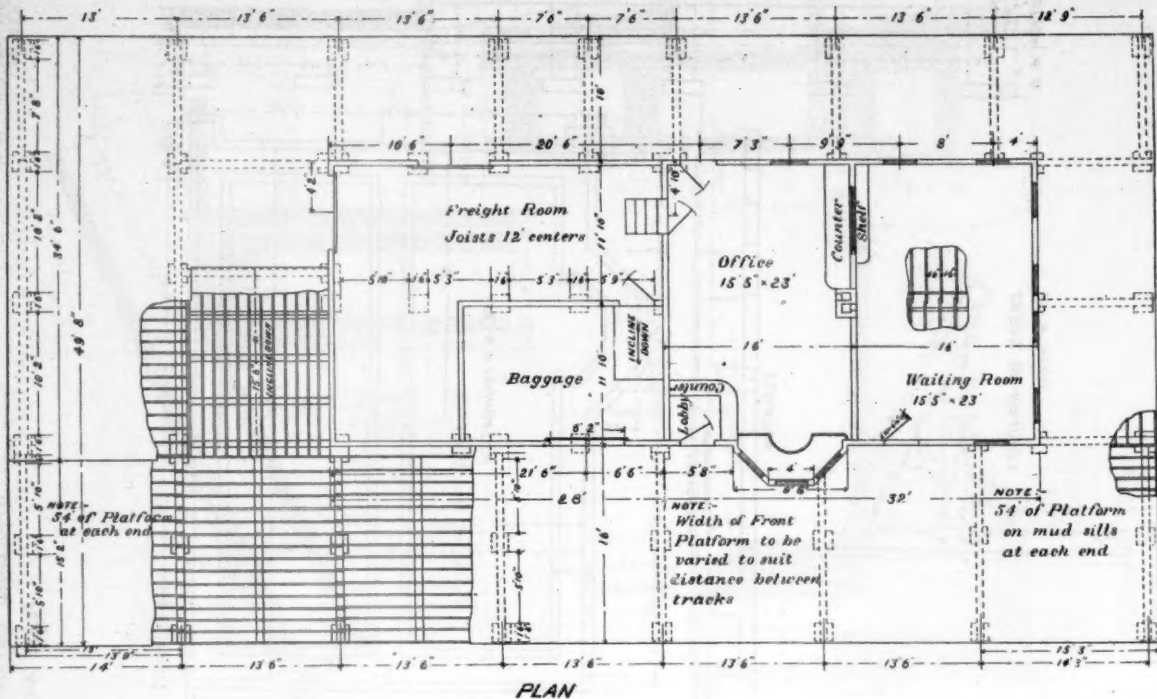
ATOHISON TOPEKA & SANTA FE RY

STANDARD DEPOT, 24'-60"
PLATE NO. 23.



STANDARD DEPOT.
PLATE No. 25.

ATCHISON TOPEKA & SANTA FE RY.



PLAN

- 10 lbs. 8 d. nails, common.
 50 lbs. 10 d. nails, common.
 10 lbs. 8 d. nails, finishing.
 10 lbs. 10 d. nails, finishing.
 2½ galls. boiled oil.
 25 lbs. white lead.
 ¾ gross No. 1 sand-paper.
 ¼ gross No. 2 sand-paper.
 50 lbs. putty.
 15 gross glazier points.

Lumber.

- 36 pieces 2 in. X 10 in. X 18 ft. first-floor joists.
 280 lin. ft. 2 in. X 10 in. common sills.
 100 pieces 2 in. X 4 in. X 18 ft. studding exterior wall.
 26 pieces 2 in. X 4 in. X 18 ft. (cut) first-story partition.
 16 pieces 2 in. X 4 in. X 16 ft. (cut) second-story partition.
 1,030 lin. ft. 2 in. X 4 in. plates, lookouts, girts, etc.
 36 pieces 2 in. X 8 in. X 8 ft. second-floor joists.
 35 pieces 2 in. X 6 in. X 18 ft. ceiling joists.
 46 pieces 2 in. X 6 in. X 12 ft. rafters.
 2 pieces 2 in. X 6 in. X 18 ft. valley rafters.
 60 lin. ft. 2 in. X 6 in. X 12 ft. ridge pieces.
 1,200 ft. B. M. s.l.s. common roof sheathing.
 2,600 ft. B. M. s.l.s. common interior sheathing.
 8 pieces ¾ in. X 5½ in. X 12 ft. ledger.
 10,000 * A shingles.
 10 pieces ¾ in. X 5½ in. X 12 ft. ridge boards.
 9,500 laths.
 290 ft. B. M. ¾ in. yellow-pine flooring, kitchen and pantry.
 1,700 ft. B. M. ¾ in. white-pine flooring.
 450 lin. ft. 1 in. X 3 in. crossbridging.
 320 ft. B. M. ¾ in. selected fence flooring placher.
 9 pieces ¾ in. X 5½ in. X 12 ft. } fascia.
 3 pieces ¾ in. X 5½ in. X 14 ft. }
 9 pieces 12 ft. } P. F. & Co. molding crown mold.
 3 pieces 14 ft. }
 12 pieces 12 ft.
 12 pieces ¾ in. X 9½ in. X 12 ft. frieze.
 4 pieces ¾ in. X 9½ in. X 12 ft. outside base.
 8 pieces ¾ in. X 9½ in. X 10 ft. outside base.
 4 pieces 1½ in. X 1½ in. X 12 ft. outside base waterdrip.
 8 pieces 1½ in. X 1½ in. X 10 ft. outside base waterdrip.
 90 pieces ¾ in. X 12 in. X 10 ft. C. stock first-story siding.
 10 pieces ¾ in. X 12 in. X 10 ft. C. stock second-story siding.

- 29 pieces ¾ in. X 12 in. X 14 ft. C. stock second-story siding.
 6 pieces ¾ in. X 12 in. X 16 in. C. stock second-story siding.
 6 pieces ¾ in. X 12 in. X 18 ft. C. stock second-story siding.
 12 pieces ¾ in. X 12 in. X 10 ft. C. stock second-story siding.
 3 pieces ¾ in. X 12 in. X 16 ft. C. stock second-story siding.
 33 pieces ¾ in. X 3 in. O. G. 14 ft.
 9 pieces ¾ in. X 3 in. O. G. 16 ft.
 6 pieces ¾ in. X 3 in. O. G. 18 ft.
 2 pieces ¾ in. X 3 in. O. G. 12 ft.
 112 pieces ¾ in. X 3 in. O. G. 10 ft.
 130 lin. ft. 1¾ in. X 7½ in. X 12 ft. and 10 ft. long, band.
 350 ft. B. M. ¾ narrow beaded ceiling, wainscot.
 344 lin. ft. ¾ in. X 7½ in. beveled base.
 4 pieces ¾ in. X 12 in. X 12 ft. pantry shelves.
 344 lin. ft. P. F. & Co. molding base mold.
 3 pieces ¾ in. X 4½ in. X 12 ft. panel finish between first and second story.
 4 pieces 1¾ in. X 2¼ in. X 12 ft. waterdrip over windows and doors.
 1 piece 2 in. X 8 in. X 10 ft. scuttle trimming.
 1 piece 1¾ in. X 3½ in. X 10 ft. scuttle batten.
 2 pieces 2 in. X 10 in. X 10 ft. outside stair stringers.
 1 piece 4 in. X 10 in. X 10 ft. mudsill.
 2 pieces 2 in. X 6 in. X 10 ft. stairs trimming.
 2 pieces 2 in. X 4 in. X 12 ft. stairs trimming.
 30 ft. B. M. narrow beaded ceiling, panels outside stairs.
 4 pieces 1½ in. X 11½ in. X 14 ft. treads.
 3 pieces ¾ in. X 7½ in. X 14 ft. risers.
 2 pieces 2 in. X 12 in. X 12 ft. cellar stairs stringers.
 4 pieces 2 in. X 10 in. X 12 ft. cellar stairs treads.
 1 piece 4 in. X 12 in. X 4 ft. cellar stairs mudsill.
 3 pieces 2 in. X 12 in. X 14 ft. first-floor stair stringers.
 5 pieces 1½ in. X 10 in. X 12 ft. first-floor stair treads.
 5 pieces ¾ in. X 8½ in. X 12 ft. first-floor stair risers.

Water Closet and Fencing.

- 7 pieces 2 in. X 12 in. X 16 ft. sides of cesspool.
 7 pieces 2 in. X 12 in. X 10 ft. ends.
 4 pieces 2 in. X 4 in. X 7 ft. corners.
 2 pieces 2 in. X 4 in. X 8 ft. sills.
 2 pieces 2 in. X 4 in. X 6 ft. sills.
 1 piece 2 in. X 10 in. X 6 ft. floor joists under partition.
 48 ft. B. M. 2 in. plank 8 ft. flooring.
 15 pieces 2 in. X 4 in. X 8 ft. studding.
 2 pieces 2 in. X 4 in. X 16 ft. girts.
 2 pieces 2 in. X 4 in. X 8 ft. plates.

- 2 pieces 2 in. \times 4 in. \times 6 ft. plates.
- 6 pieces 2 in. \times 4 in. \times 8 ft. rafters.
- 12 pieces $\frac{3}{4}$ in. \times 12 in. \times 10 ft. C. stock siding.
- 16 pieces $\frac{3}{4}$ in. \times 12 in. \times 9 ft. C. stock siding.
- 24 pieces 3 in. O. G. battens, 18 ft.
- 12 pieces $\frac{3}{4}$ in. \times 12 in. \times 18 ft. D. stock lining.
- 80 ft. B. M. D. stock 10 ft. roof boards.
- 600 * A shingles.
- 2 pieces 3 in. crown mold, 18 ft.
- 2 ventilators.

Fencing.

- 49 pieces cedar posts, 5 in. diameter at small end.
- 130 pieces 1 in. \times 6 in. \times 16 ft. rough fencing boards.

Walk to Privy.

- 180 ft. B. M. $\frac{3}{4}$ in. \times 18 ft. fencing.
- 120 lin. ft. 2 in. \times 4 in.

Hardware.

- 50 lbs. 3 d. shingle nails.
- 65 lbs. 3 d. fine lath nails.
- 2 kegs 20 d. nails, common.
- 1 keg 10 d. nails, common.
- $\frac{3}{4}$ keg 8 d. nails, common.
- 40 lbs. 10 d. nails, finishing.
- 17 lbs. 8 d. nails, finishing.
- 25 lbs. 6 d. nails, finishing.
- $\frac{1}{4}$ gross $1\frac{1}{2}$ in. wood screws No. 10.
- 2 gross 1 in. wood screws No. 10.
- 250 yds. plain building paper.
- 3 galls. shellac varnish.
- 4 galls. turpentine.
- 8 lbs. putty.
- 2 lbs. drop black.
- 4 pairs 3 in. \times 3 in. wrought butts, transoms and cellar windows.
- 4 pieces spring catches, transoms and cellar windows.
- 1 pair 4 in. \times 4 in. wrought butts, scuttle.
- 1 6-in. hinged hasp and staple, scuttle.
- 8 pieces sash weights, $6\frac{3}{4}$ lbs. each, kitchen windows.
- 50 lin. ft. $\frac{1}{4}$ in. white Silver Lake sash cord No. 8.
- 2 pieces Berlin bronzed sash locks.
- 52 pieces window spring bolts.
- 104 pieces window sockets.
- 2 pieces 5-in. hooks with 2 eyes, cellar windows.
- 13 pairs $3\frac{1}{2}$ in. \times $3\frac{1}{2}$ in. loose pin cast butts, doors.
- 13 thumb latches.
- 2 pieces right-hand rim night latches.
- 1 piece left-hand rim night latches.
- 28 lin. ft. 14 in. continuous I. C. flashing tin, scuttles and chimneys.
- 34 lin. ft. 20 in. continuous I. C. gutter tin, valleys.
- 6 sq. ft. roofing tin I. C. (2 ft. \times 3 ft.), scuttle.
- 3 pieces soot drawers, 6 in. \times $8\frac{1}{2}$ in. \times 13 in.
- 4 doz. wardrobe hooks.
- 3 pieces ventilating grates.
- 5 lbs. 8 d. clinch nails.
- 5 pieces terra-cotta stovepipe thimbles, 6 in. \times $4\frac{1}{2}$ in.
- 2 pieces terra-cotta stovepipe thimbles, 6 in. \times 9 in.
- 60 galls. mineral paint.
- 20 galls. boiled oil.
- 75 lbs. white lead.
- 3 cast-iron chimney caps.

Water Closet and Fencing.

- 10 lbs. 20 d. common nails.
- 10 lbs. 10 d. common nails.
- 6 lbs. 8 d. common nails.
- 4 lbs. 3 d. shingle nails.
- 3 lbs. 8 d. clinch nails.
- 2 pairs 3 in. \times 3 in. wrought butts, with screws.
- 2 thumb latches.
- 1 night lock.
- 8 ft. $\frac{1}{4}$ in. \times 1 in. bar-iron for ventilator.

Fence.

- 25 lbs. 8d. fencing nails.
- 2 pieces 6 in. strap hinges and screws.
- 1 St. Louis gate latch.
- 10 galls. mineral paint.
- $2\frac{1}{2}$ galls. boiled oil.
- 1 set Western gate hinges.

Privy Walk.

- 5 lbs. 8 d. common nails.

Limes, Cements, etc.

- 20 bbls. white lime.
- $2\frac{1}{2}$ bbls. plaster of Paris.
- 20 bush. plastering hairs.
- 2 bbls. common lime.
- 25 bbls. cement.
- 2,200 bricks.

CHAPTER X.

SMALL STATIONS.

In regard to the plans for STATION-HOUSES, we take up only smaller wooden stations, for the reason that the larger ones, such as are built in cities and towns of any importance, are usually put into the hands of professional architects, and do not properly come within the scope of the railroad engineer.

Plates Nos. 23, 24 and 25 show the standard 24 \times 60 ft. station of the Atchison, Topeka & Santa Fé Railroad. There are no bills of material given with these plans, from the fact that the dimension of every piece of timber required is noted on the plan, and also that every detail is given in a larger scale, so that for any particular case it would require very little work for the engineer to make out a bill of material which would answer for the occasion, and any one bill of material that could be made out, and that would answer for any one particular locality, would probably, for local reasons, not be the most economical that could be used in some other.

Some general remarks on stations, and some additional plans for small station-houses, are necessarily deferred to the next chapter.

(TO BE CONTINUED.)

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. FORNEY.

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(Continued from page 238.)

CHAPTER XXVII.

WATER-TANKS AND TURN-TABLES.

QUESTION 716. *How are locomotive tenders or tanks supplied with water?*

Answer. At suitable places, called *water stations*, along the line of the road, large tanks or reservoirs, *H H*, fig. 415, are located, which are filled either from natural streams which are higher than the tanks and thus flow into the latter, or else the water is pumped in, either by hand or by horse, wind, water, or steam power. When there is room for them, these tanks are usually located near the track, as shown in fig. 415, so that the water can be conducted by a spout, *a*, direct from the tank to the man-hole of the tender, *T*. Communication to and from this spout is opened and closed by a valve, *b*, inside of the tank, which is moved from the tender by a rope, *c*, connected to a lever, *f*, and to the valve, *b*. The spout is usually attached to the tank by a hinged joint, so that it can be lowered to the tender and then raised up out of the way of the engine and train. It is generally balanced by a counterweight, suspended to one end of a rope, *d*, which passes over a pulley and is fastened to the spout at the other end. The tanks are now generally made of wooden staves like a tub or pail, and supported on a heavy frame, *c c c*, made of wood, as shown in the engraving, or on stone or brick masonry.

When there is no room for the tank or reservoir near the track, it is placed in any convenient position at some distance from it, and the water is then conveyed by an underground pipe to the place where the locomotive must take water. At the end of this pipe what is called a *stand-pipe* or *water-crane*, fig. 416,* is located. This consists of a vertical pipe, *A*, with a horizontal arm, *B*, which is made so as to swing around over the man-hole of the tender when the latter is to be filled with water. In some cases the horizontal arm alone swings around, but in others the vertical pipe turns with the horizontal one in a joint, *C*, underneath the surface of the ground. The latter plan is thought to be preferable to the first, as the pipe is less

* The engraving illustrates a stand pipe, made by the Sheffield Velocipede Car Co., of Three Rivers, Mich.

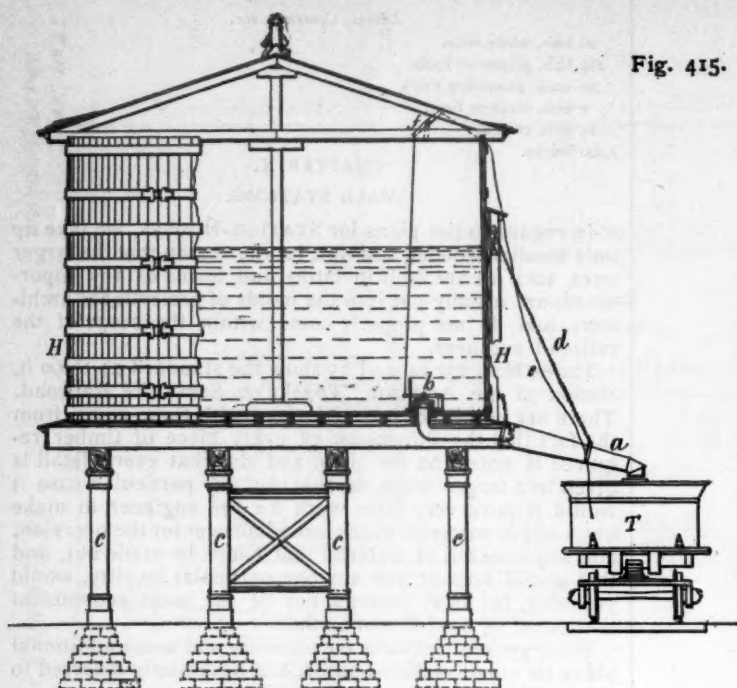


Fig. 415.

liable to freeze fast in the joint when the latter is underground than when it is exposed above. A suitable valve, *D*, is also attached to the pipe below ground, so that the stream of water can be turned off or on at pleasure by the lever *E*, which is connected by rods to the valve.

QUESTION 717. *What effect does the use of impure water have on a locomotive boiler?*

Answer. The use of impure water, or that which contains a considerable amount of mud or solid matter mixed with it, or in suspension, as it is called, or has lime or other mineral substances chemically combined with it, will very soon coat the inside of the boiler with a covering of scale, which is a very bad conductor of heat, and consequently the boiler is much less efficient and much more heat is wasted than if the heating surfaces were clear. Besides this loss of efficiency, when boiler plates are covered with non-conducting scale, they are much more liable to be injured by the action of the fire than when the water comes directly in contact with the metal of the plates. Some water, too, has a corroding effect on the metal of the boiler which is very destructive.

QUESTION 718. *What considerations should determine the source from which a supply of water should be drawn?*

Answer. The first must of course be its convenience to the point where the water is to be used; but more attention should be given to the quality of the water than it ordinarily receives. The location where a water-tank must be having been decided upon, every possible available source of supply should be sampled, and analysis made of each of the samples and the corrosive substance which it contains, and the solid residue which is left after the water is evaporated should be determined. This having been done, the source which contains the least corrosive or scale-making material should be chosen. In general running streams are much better than any other sources. Wells very rarely are good sources of supply. Much expense can be saved in boiler repairs and in the fuel account by a little judicious expenditure of money to secure a supply of good water. On many of the older railroads an examination of all possible sources of water-supply is now being made, with a view to abandoning a large number of the old sources, and securing others near by which contain much less scale-making material. If this had been done when the roads were first located, much extra cost for fuel and repairs would have been saved.

QUESTION 719. *How can the relative amount of incrustating substances in different kinds of water be determined?*

Answer. The relative quantity of solid matter or mud which is held in suspension can be at least approximately determined by simply filling vessels, say large

clear glass bottles, with different kinds of water and adding a few drops of water of ammonia, and letting them stand for some time until the solid matter settles to the bottom.

A comparison of one water with another, as to its scale-making properties, may readily be obtained by having samples of the different waters in some small bottles of the same size, adding to them water of ammonia until each is distinctly alkaline, and then a little phosphate of soda. This causes a precipitation of the iron, alumina, lime, and magnesia in the water as phosphates, and the bulk of the precipitate indicates the relative amount of scale-making material. This test is, of course, crude, and would hardly take the place of a good chemical analysis, but it is much better than nothing.

When the water of ammonia cannot easily be procured, an experiment may be tried, in the same way, by dissolving common white soap, or other pure soap, in a goblet of pure water, and then stirring into the glasses of water to be tested a few teaspoonfuls of this solution. The comparative amount of scale-making material in the water will be shown by the amount of coagulated matter which will be thrown down.

QUESTION 720. *What are the most commonly occurring corrosive materials in waters used in boilers?*

Answer. The most commonly occurring corrosive materials are sulphates of iron and alumina and chloride of magnesium. The former are universal constituents of mine drainage. The latter occurs most frequently along the sea-shore. In addition to this many waters which drain from mines contain

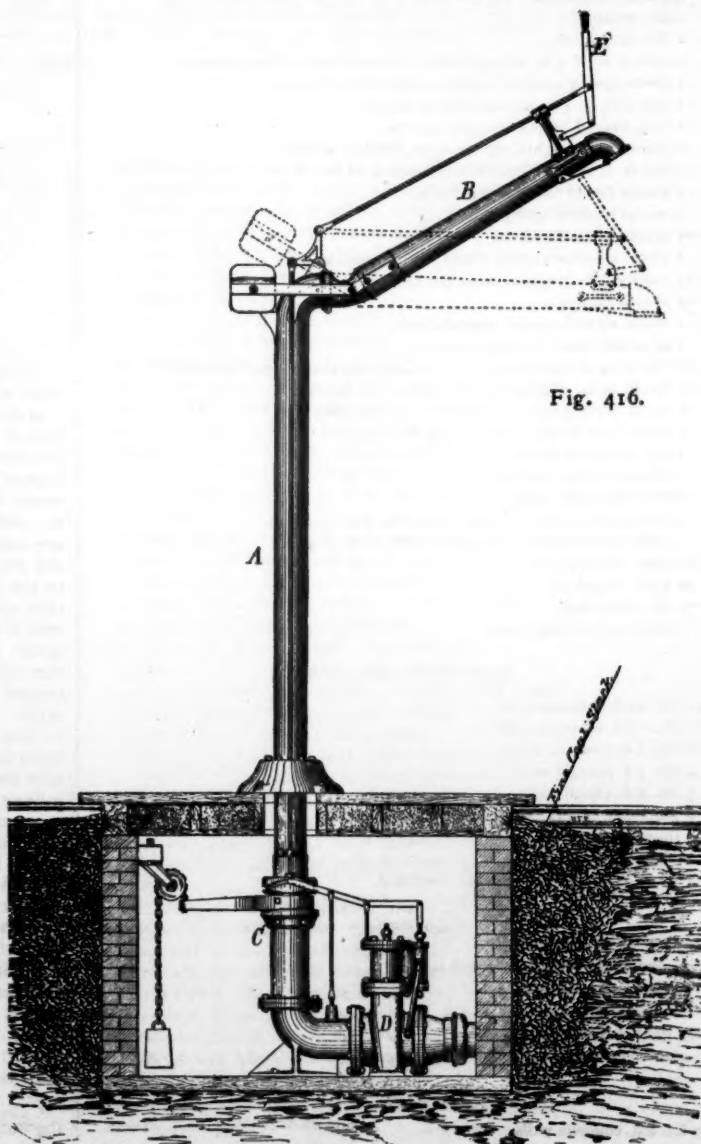


Fig. 416.

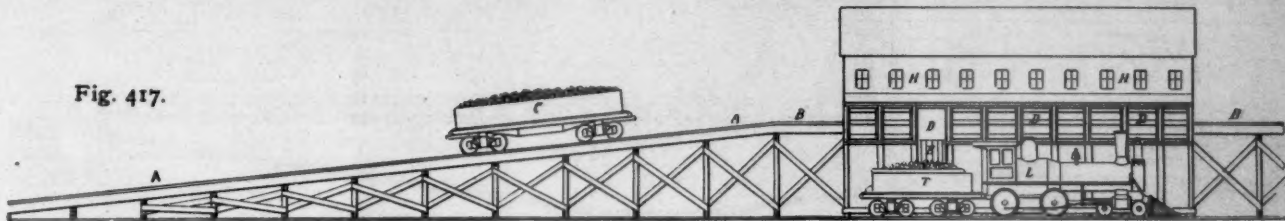
large amounts of free sulphuric acid. If any mine drainage gets into the water-supply at any place, the use of that water should be abandoned if possible. Also in wells along the sea-shore, or on the banks of rivers affected by the tides, chloride of magnesium is a frequent constituent, and often causes serious corrosion of boilers.

QUESTION 721. *How are locomotive tenders supplied with coal?*

Answer. This is done in a variety of ways. Sometimes the coal is shoveled from cars alongside of the tender, but this is a slow and laborious method. In other cases iron buckets are filled with coal at stations and then are hoisted by cranes and

are laid in the ordinary way on top of the girders they will be exactly level with the track which leads up to the pit. By turning the girders on the central pivot so that the rails will come exactly in line with the permanent track which leads up to the pit, the locomotive can be run on the turn-table, which is then revolved a half-revolution, which of course reverses the position of the locomotive and brings it opposite the permanent track so that it can be run off from the table. In order to prevent the girders from tipping down when the engine first runs on or off of the turn-table, wheels, *W W*, are placed at their outer ends which run on a circular track, *D D*, and they

Fig. 417.



swung over the tenders. They are then either tipped or a door in the bottom is opened and the contents are emptied into the tender. In still other cases, small cars are loaded with coal and are run on platforms which are high enough, so that the contents of the cars can be dumped into the tender. Fig. 417 represents a side view and fig. 418 a transverse section of what is called a coal chute.* It consists of an inclined track, *A A*, which leads to an elevated level track, *B B*, in a building, *H H*. On one or both sides of this track the building has receptacles or "pockets," as they are called, *F*, fig. 418, to receive the coal from the cars. These pockets have inclined floors, *G*, and are closed by doors, *D D*, figs. 417 and 418. Each pocket also has a spout or "apron," *E*, which can be extended out over the tender, as shown in fig. 418. These aprons are hinged at *I*, and can be folded up out of the way when not in use. The pockets are filled with coal, and when a tender, *T*, is to be supplied it is run on a track alongside of the coal chute opposite to one of the pockets. The apron, *E*, is then lowered and the door *D* opened, and the contents of the pocket are emptied into the tender in a few seconds.

In some cases coal chutes are furnished with scales for weighing the coal supplied to tenders.

bear any inequality of weight that may be thrown on them if the locomotive is not equally balanced on the central pivot.

QUESTION 723. *How is the central pivot constructed?*

Answer. It usually consists of a vertical post, *F* (shown in fig. 421, which is a transverse section through the center of the

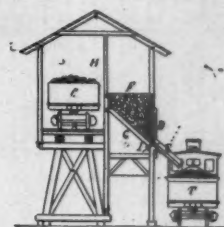


Fig. 418.

turn-table), the end of which has a hard cast-iron or steel bearing. In some cases, the weight rests on conical steel rollers, which revolve in a circular path formed in the top plates. Sometimes turn-tables are fitted with gearing and cranks, but if they are made so that the whole weight rests on the center,

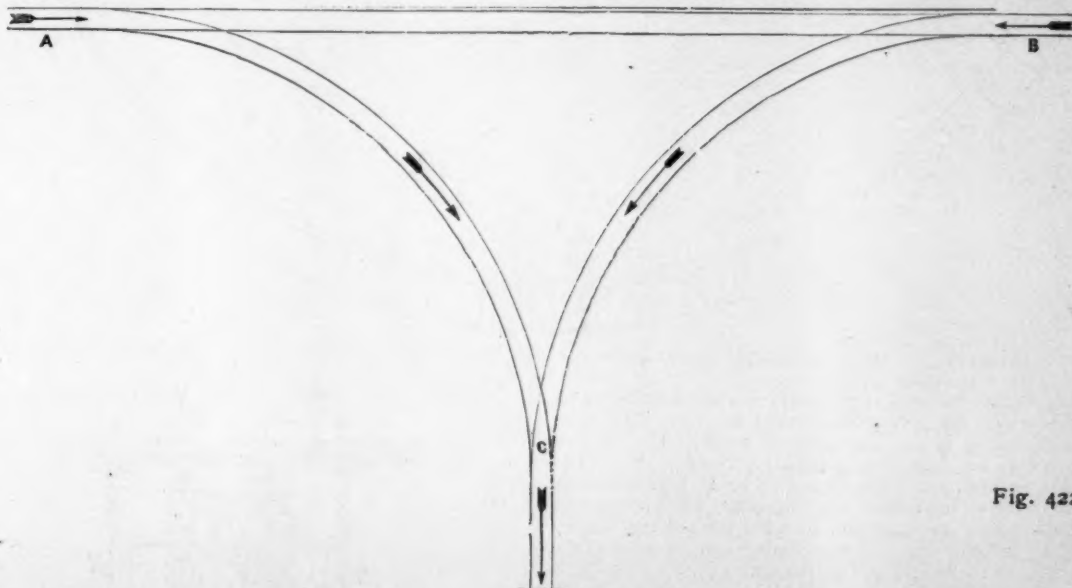


Fig. 422.

QUESTION 722. *How are locomotives turned around on the track?*

Answer. The most common means employed for that purpose is a turn-table, of which fig. 419 is a side elevation, fig. 420 a plan, and fig. 421 a cross-section through the center on the line *a b*.† It consists of two heavy beams or girders made of wood, cast or wrought iron, placed side by side and resting on a pivot, *P*, fig. 421, in the center, on which they turn. They are placed in a circular pit, *C C* (part of which is omitted in the plan), below the level of the track, *A A*, so that when rails

and if they are of sufficient length so that an engine and tender can be moved on them sufficiently to be balanced over the center, gearing will not be needed; but a simple lever fastened to the turn-table will be all that will be required to turn the table and the engine and tender on it. The tables should be of such a diameter or length across the center as will enable the class of engine in use on any road to be balanced. With light engines a table 50 ft. in diameter is large enough; with the long, heavy engines now used on the great trunk lines, an engine and tender quite fill up the entire length of 50 ft., leaving no margin for adjustment. In such cases a table 60 ft. in diameter should be employed. These large tables are also made heavier in proportion. When the engine

* The figures represent a coal chute made and patented by Williams, White & Co., of Moline, Ill.

† Designed by A. P. Boller, C.E., 71 Broadway, New York.

Fig. 419.

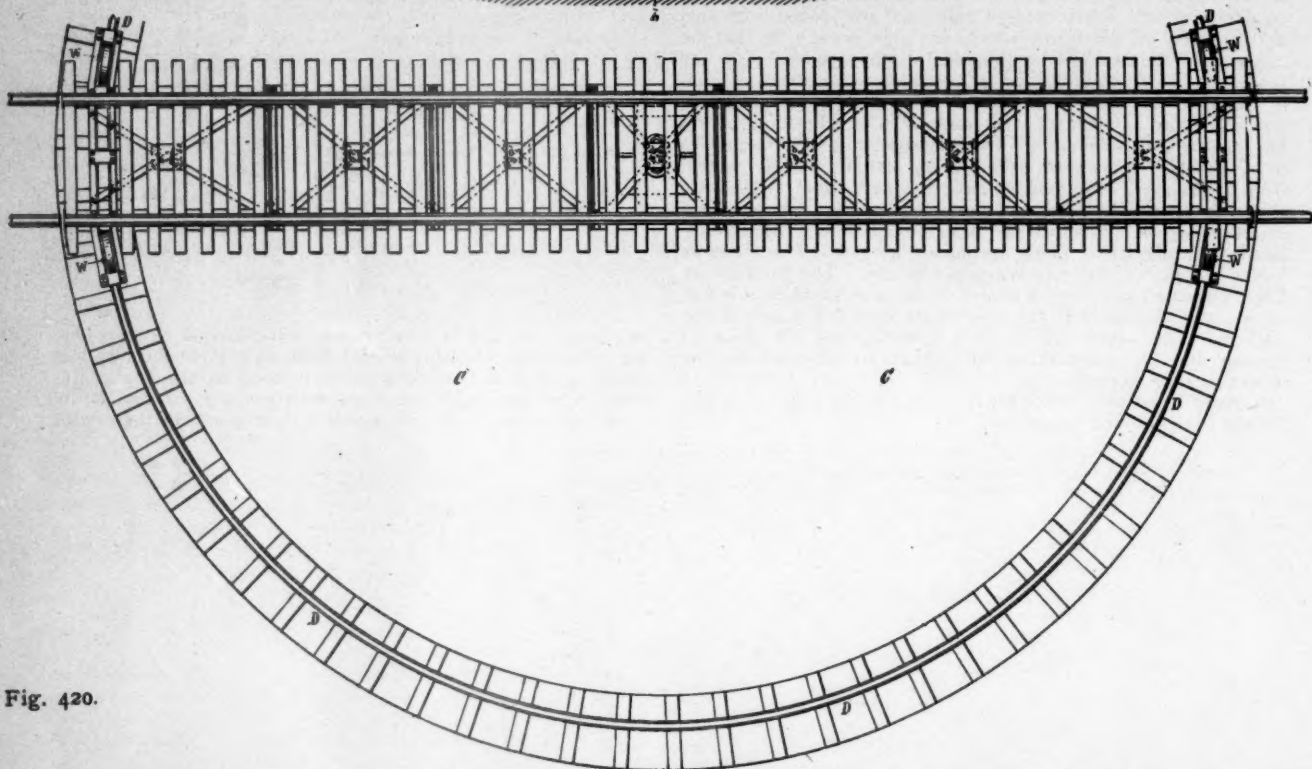
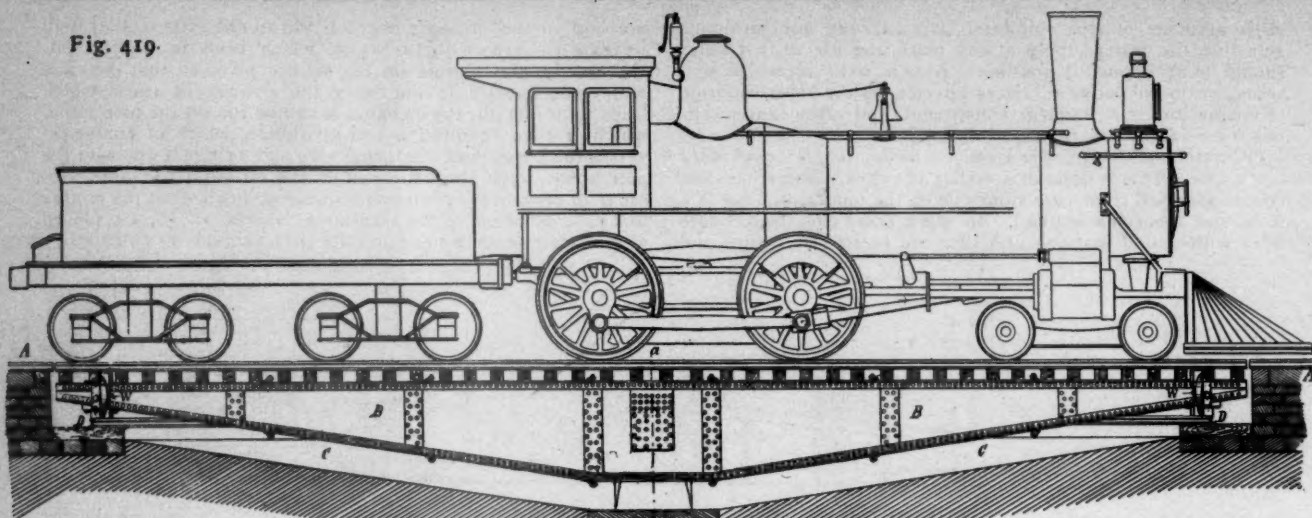


Fig. 420.

and tender is balanced over the center pivot, one man can turn the loaded table with ease.

In setting up turn-tables it is necessary that the foundation at center, upon which the pivot rests, should be of the most substantial character, so as not to be liable to settle. The circular track, which may be made of light rails, say 28 or 30 lbs. to the yard, should be level, and the table should be so adjusted as to swing clear of the circular track when loaded. The pit required is quite shallow near the edge and deepens toward the center, and should be properly drained to prevent water from standing in it. Provision is made for covering the entire pit by a platform turning with the table, but this should be avoided whenever possible, as the best-constructed cover does offer some resistance in turning. Even in roundhouses, where a covered pit might be considered preferable as presenting a smooth floor for crossing in any direction, it has been found advisable, in view of the greatest ease in turning and the facility offered by the open pit for cleaning, to dispense with the cover. The center of the table must be kept clean and well oiled, say with best sperm or lard oil and tallow of such a consistency as not to harden in cold weather. The top cap at center is held in place by bolts, *G G*. These bolts take the entire weight of the table and load; by slacking off the bolts the table can be lowered on the wheels on the circular track and the cap lifted off to gain access to the bearings. This should be opened, examined and cleaned at least once every three months.

QUESTION 724. *Is there any other method of turning locomotives?*

Answer. Yes; what is called a *V* is sometimes used. This

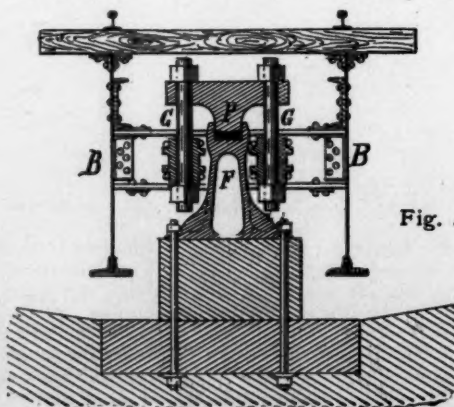


Fig. 421.

consists of a system of tracks laid somewhat in the form of the letter *V*, as shown in fig. 422, in which *AB* is the main track, with two curves, *AC* and *BC*, laid as shown. If it is de-

sired to turn a locomotive which is standing in the position of the dart *A*, it is run on the curve *A C* to the position of the darts *a* and *C*. It is then run backward from *C* on the curve *C b B*, as represented by the dart *b*, and when it reaches the main track in the position of the dart *B* it is evident that its position will be reversed, as is shown if we compare the direction of the dart *A* with that of *B*.

CHAPTER XXVIII.

PERFORMANCE AND COST OF OPERATING LOCOMOTIVES.

QUESTION 725. What are the elements of cost of operating locomotives?

Answer. They are (1) the cost of fuel; (2) of the service or wages of the engineer and fireman; (3) of lubricating and illuminating oil, waste, and miscellaneous supplies; (4) of repairs to the engine and tender, and (5) cleaning and watchmen.

QUESTION 726. In what way may the cost of operating locomotives be counted and compared?

Answer. The cost is usually counted at so much per train mile or per car mile.

QUESTION 727. What is the usual cost of these items of expense?

Answer. The cost per train mile, of course, varies very much with the loads hauled, the speeds, grades, condition of the road, weather, price of coal, etc. The following table, taken from one of the monthly performance sheets of the Lake Shore & Michigan Southern Railroad, gives the cost per train mile for the different classes of trains:

COST OF LOCOMOTIVE SERVICE.

KIND OF TRAIN.	COST PER TRAIN MILE.					
	Fuel, Cents.	Wages, Cents.	Oil Waste, etc., Cents.	Repairs, Cents.	Cleaning and Watchman, Cents.	Total, Cents.
Passenger....	4.27	6.61	.05	3.77	.21	14.91
Freight.	6.43	6.61	.05	3.33	.21	16.63
Working....	2.86	6.61	.05	2.03	.21	11.76
Switching...	2.57	6.61	.05	2.19	.21	11.63
Average.....	4.94	6.61	.05	3.15	.21	14.96

The Lake Shore line has no very steep grades, and consequently its engines are not so heavy as on some other lines. On the Pennsylvania Road, for example, which has steep grades and heavy engines, the average cost of repairs in 1887 was 6.43 cents per train mile, or more than double that on the Lake Shore line, for the month quoted.

QUESTION 728. What proportion do the locomotive expenses bear to the total cost of operating a railroad?

Answer. In 1888, on the Lake Shore Railroad, the expenses named in the table were nearly 15 per cent. of the total operating expenses.

QUESTION 729. How much coal is consumed per mile by a locomotive and tender without a train?

Answer. No very reliable experiments have been made with large engines to determine this, but in some experiments which were reported to the Master Mechanics' Association in 1876,* it was shown that the coal consumed in running an engine and tender, the total weight of which was about 50 tons, over a road without a train at an average speed of between 20 and 25 miles per hour, was from 18½ to 25½ lbs. of coal per mile, or an average of 21 lbs. Experiments with an English engine showed a consumption of 12 lbs. per mile. The tests reported to the Master Mechanics' Association were, however, made with Western coal, which is not of so good a quality as English coal.

QUESTION 730. How much coal do locomotives usually consume per train mile in ordinary service?

Answer. This, too, varies within very wide limits. On the Lake Shore line, for example, the consumption for the year 1888 per train mile was 70 lbs. On the Pennsylvania road, in 1887, it was 91.2 lbs., whereas on the Philadelphia & Erie line, for the same period, it was 105.4 lbs.

QUESTION 731. How much coal is consumed per car per mile?

Answer. On the Pennsylvania Railroad, in 1887, the consumption of coal was 12.37 lbs. per passenger car per mile, and the average number of cars per train was 4.89. This was the total consumption of fuel by the locomotive which was apportioned to the cars alone, no coal being allowed for moving the engine and tender.

In the same year the consumption of coal per freight car

per mile was 5.03 lbs. per car per mile, and the average train consisted of 24.16 cars. On the Philadelphia & Erie Division, which is a nearly level line, the coal consumed was only 3.18 lbs. per car per mile, and the average train consisted of 38.78 cars. The consumption of coal was divided among the cars alone, no allowance being made for the engine and tender. The monthly premium sheets of the Pennsylvania Railroad show that the consumption of coal, if apportioned to the cars alone, varies from 3.8 to 17 lbs. per freight car per mile, and from 9 to 24 lbs. for passenger cars. These figures give the average results on the roads named.

The following report of experiments, which were carefully made by the writer, will give the performance of a locomotive when great care is taken to produce good results. It should be stated, however, that the engine with which these experiments were made had been in service 18 months without receiving thorough repairs, and that the boiler at times primed badly, so that the rate of evaporation of water per pound of coal is not a fair indication of the performance of the engine in that respect. The coal used was known as Brazil coal, from Indiana, and in order to compare the performance of two engines only lumps of coal were used, so as to leave no room for question regarding the relative amount of fine coal used by each engine. The maximum grades on the road on which the experiments were made were 30 ft. per mile, and the total ascent from the lowest to the highest point on the road was 374 ft.

LOCOMOTIVE EXPERIMENTS.

Date of experiment.....	1873.	1873.	1873.
	July 21.	July 28.	August 2.
Number of miles run.....	145	145	145
Number of cars hauled.....	41	31	41
Total weight of cars, lbs.....	1,497,240	1,119,650	1,508,860
Total amount of coal burned, lbs.....	8,676	5,102	7,221
Total amount of water consumed, lbs....	63,531	45,719	52,609
Water evaporated per lb. of coal, lbs....	7.32	8.02	7.64
Miles run per ton (of 2,000 lbs.) of coal....	33.4	50.8	38.8
Coal consumed per car per mile, lbs.....	1.45	1.13	1.21
Average speed, including stops, miles....	11.1	13	13.8

QUESTION 732. How can we determine the speed at which an engine is running?

Answer. In the absence of any special instruments for the purpose, by COUNTING THE NUMBER OF REVOLUTIONS OF THE DRIVING-WHEELS PER MINUTE, THEN MULTIPLYING THE LENGTH OF THEIR CIRCUMFERENCE IN INCHES BY THE NUMBER OF THEIR REVOLUTIONS PER MINUTE AND THE PRODUCT BY 60, AND DIVIDING THE LAST PRODUCT BY 63,360. THE QUOTIENT WILL BE THE SPEED IN MILES PER HOUR. Thus, supposing driving-wheels which are 61½ in. in diameter, and whose circumference is therefore 193.2 in., should make 164 revolutions per minute, then $193.2 \times 164 \times 60 \div 63,360 = 30$ miles (nearly) per hour.

CHAPTER XXIX.

LUBRICATING CUPS.

QUESTION 733. How are the journals of the axles of locomotives lubricated?

Answer. The driving and engine truck axle boxes have oil-holes and receptacles on top, which are filled with cotton or woolen waste, into which the oil is poured when the engine is standing still. The tender axle boxes have receptacles below



[Fig. 423.]

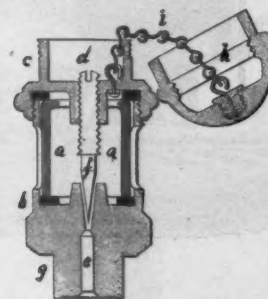


Fig. 424.

the journals, which are filled with waste and saturated with oil, as was explained in answer to Question 451.

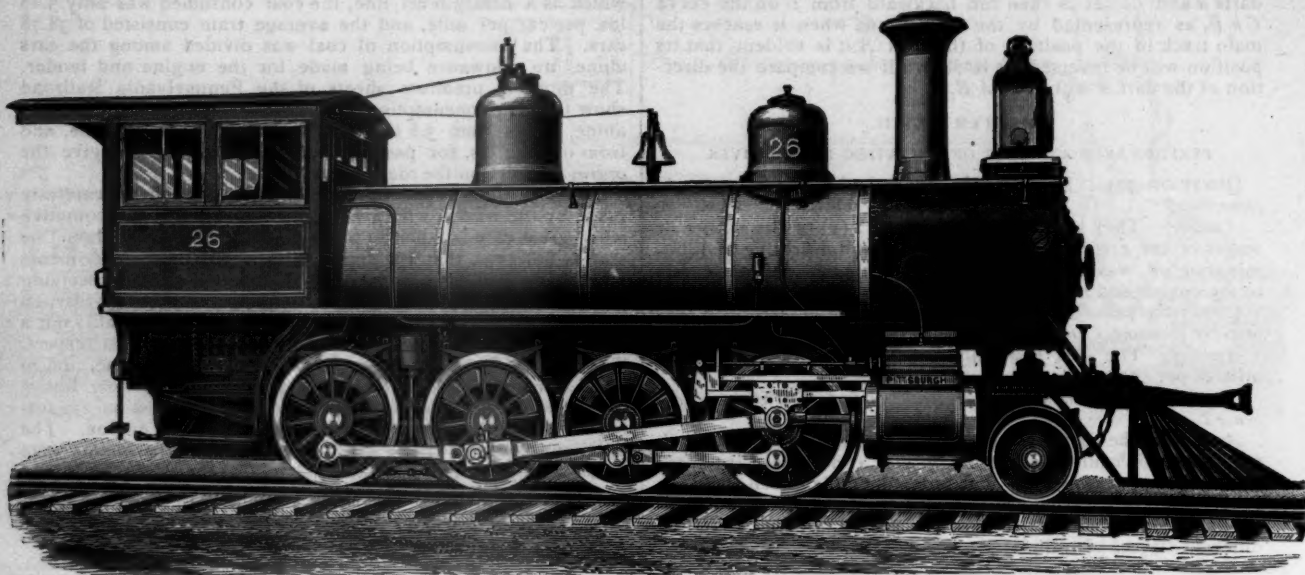
QUESTION 734. How are the crank-pins and cross-head guides lubricated?

Answer. The guides and the connecting-rods have oil or lubricating cups attached to them above the bearings. Such cups are shown in Plate III, on top of the guide-bars 62, and above the crank-pins 55. Fig. 423 is an outside and fig. 424 a sectional view of an oil-cup for locomotive guides.* It consists

* See report of that year, page 145.

* Manufactured by the Nathan Manufacturing Company of New York.

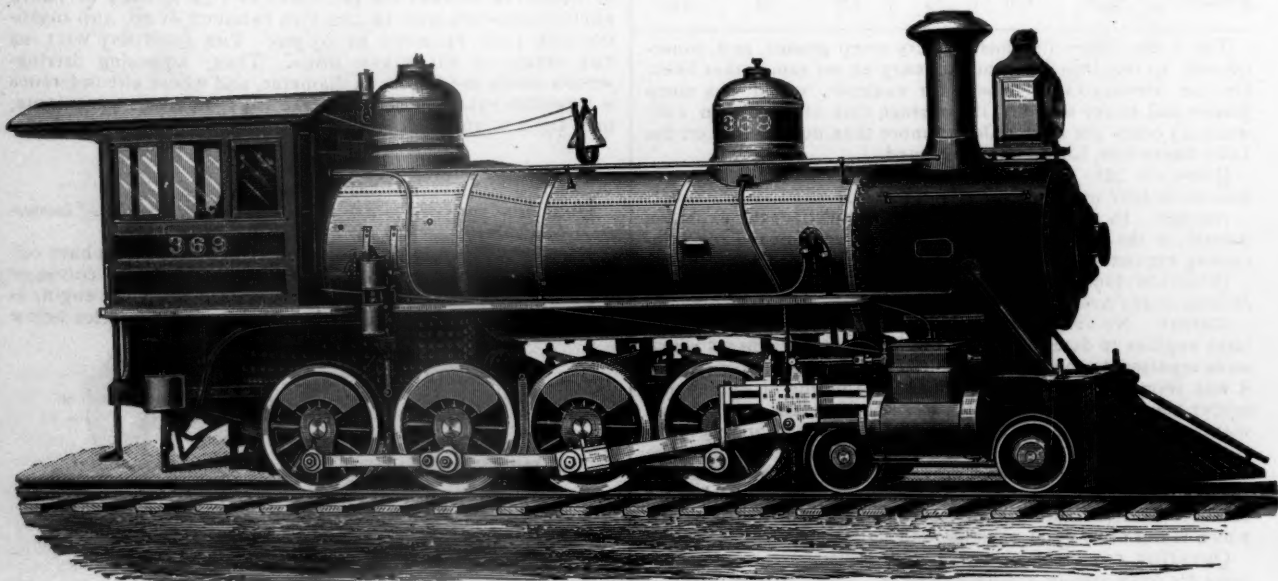
CATECHISM OF THE LOCOMOTIVE.



CONSOLIDATION LOCOMOTIVE.

BY THE PITTSBURGH LOCOMOTIVE WORKS, PITTSBURGH, PA.

Total weight in working order.....	104,900 lbs.	Outside diameter of smallest boiler ring.....	4 ft. 8 in.	Exhaust nozzles.....	Double.
Total weight on driving-wheels.....	94,150 "	Length of fire-box, inside.....	8 " 6 "	Size of steam-ports.....	16x1 1/4 in.
Diameter of driving-wheels.....	4 ft. 2 in.	Width of fire-box, inside.....	2 " 10 3/4 "	Size of exhaust-ports.....	16x2 1/2 "
Diameter of truck-wheels.....	2 " 6 "	Depth of fire-box, crown-sheet to top of grate.....	4 " 5 3/4 "	Throw of eccentrics.....	5 "
Diameter of main driving-axle journal.....	7 "	Number of tubes.....	202	Greatest travel of valve.....	5 " 1/4 "
Length of main driving-axle journal.....	9 "	Outside diameter of tubes.....	2 in.	Outside lap of valve.....	5 " 1/4 "
Distance from center of front to center of back driving-wheels.....	14 ft. 2 "	Length of tubes.....	13 ft. 2 "	Smallest inside diameter of chimney.....	1 ft. 6 " 3/4 "
Total wheel-base of engine.....	21 " 9 "	Grate surface.....	24.34 sq. ft.	Height, top of rail to top of chimney.....	14 " 5 1/2 "
Total wheel-base of engine and tender.....	47 " 10 1/2 "	Heating surface, fire-box.....	132.00 "	Height, top of rail to center of boiler.....	6 " 9 1/2 "
Diameter of cylinders.....	20 "	Heating surface, tubes.....	1,383.00 "	Water capacity of tender tank.....	3,000 gals.
Stroke of cylinders.....	24 "	Heating surface, total.....	1,515.00 "		



TWELVE-WHEEL LOCOMOTIVE.

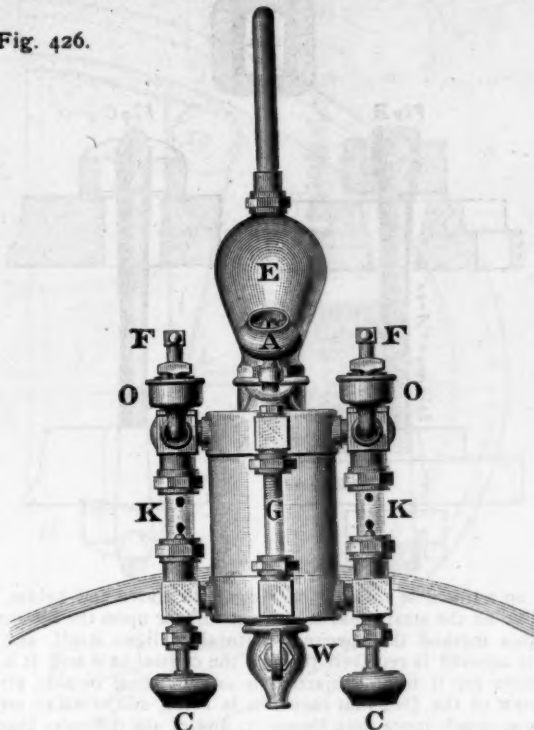
BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

Total weight in working order.....	132,000 lbs.	Outside diameter of smallest boiler ring.....	5 ft. 0 in.	Exhaust nozzles.....	Single.
Total weight on driving-wheels.....	112,000 "	Length of fire-box, inside.....	8 " 8 3/4 "	Size of steam-ports.....	18x1 1/4 in.
Diameter of driving-wheels.....	4 ft. 3 in.	Width of fire-box, inside.....	3 " 6 "	Size of exhaust-ports.....	18x2 1/2 "
Diameter of truck-wheels.....	2 " 8 "	Depth of fire-box, crown-sheet to top of grate.....	4 " 11 "	Throw of eccentrics.....	5 1/2 "
Diameter of main driving-axle journal.....	7 1/2 "	Number of tubes.....	262	Greatest travel of valve.....	5 1/2 "
Length of main driving-axle journal.....	8 3/8 "	Outside diameter of tubes.....	2 in.	Outside lap of valve.....	5 1/2 "
Distance from center of front to center of back driving-wheels.....	13 ft. 9 "	Length of tubes.....	12 ft. 8 "	Smallest inside diameter of chimney.....	1 ft. 4 " 3/4 "
Total wheel-base of engine.....	23 " 6 "	Grate surface.....	31 sq. ft.	Height, top of rail to top of chimney.....	14 " 10 "
Total wheel-base of engine and tender.....	47 " 10 "	Heating surface, fire-box.....	156 "	Height, top of rail to center of boiler.....	7 " 6 1/2 "
Diameter of cylinders.....	20 "	Heating surface, tubes.....	1,726 "	Water capacity of tender tank.....	3,400 gals.
Stroke of cylinders.....	26 "	Heating surface, total.....	1,882 "		

NOTE.—In this engine the first and third pairs of driving-wheels have blank tires, so that the rigid wheel-base is only 9 ft. 2 in.

of an internal glass-cup, *a a*, which is enclosed in a brass case, *b*, which has round openings on its four sides, so that it can be seen how much oil the cup contains. The glass cup is held in place by a cap, *c*, which is screwed on the case *b*. India-rubber washers are placed above and below the glass cup, to make tight joints when the cap is screwed down. The oil is poured

Fig. 426.



into the cavity *d* in the cap *c*, and runs down into the glass cup *a*, through openings not shown in the engraving. From *a* it flows to the bearings through the opening *e*. The rate of flow is regulated by a conical screw-plug, *f*, which can be adjusted so as to increase or diminish the flow of oil to the bearings. The lower part, *g*, of the cup is screwed into the guide-bars. The cap, *c*, has a loose cover, *h*, to exclude dirt from the cup. It is held by a chain, *i*, to prevent its being lost.

Fig. 425 is an external view of a similar oil-cup for connecting-rods. The cap is screwed on the case, and the flow of oil



Fig. 425.

is adjusted by a small rod or pin, the lower end of which rests on the surface of the crank-pin.

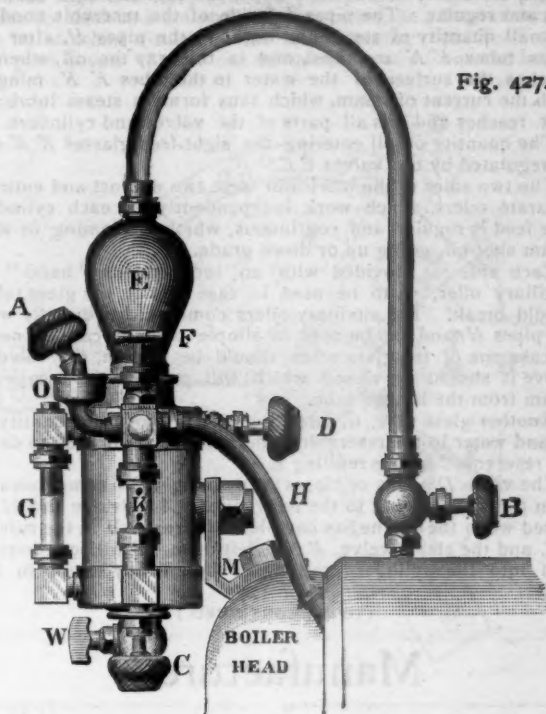
There are a great variety of oil-cups in use, and much ingenuity has been exercised in devising appliances to regulate the supply of oil.

QUESTION 735. *How are the slide-valves and pistons of a locomotive lubricated?*

Answer. The method which was formerly employed was to attach an oil-cup to the top of the steam-chest, by which oil was supplied to the valve below when steam was shut off. To do this the fireman had to go to the front end of the engine. To avoid this pipes were connected to the steam-chests, and extended back to the cab with oil-cups in the cab, so that the valves could be oiled from the cab without going out to the front of the engine. Of late years what are called "sight-feed lubricators," which supply oil continuously to the cylinders, are used. These are placed in the cab, and are connected to the

steam-chests by pipes. Fig. 426 represents an end view, fig. 427 a side view, and fig. 428 a sectional view on a plane parallel to that of fig. 426.* In lubricators of this class the weight of a column of water displaces the oil in the cup, and causes it to flow upward, drop by drop, through water in glass-tubes to the pipes, which are connected to the steam-chests.

Fig. 427.



In fig. 428 *I* is the reservoir for holding the oil, which is filled through the plug *A*, fig. 427; *E* is a condenser, to which steam is conducted by a pipe on top connected to the boiler, as shown in fig. 427. As the steam is condensed in *E*, fig. 428, the water of condensation flows down into the reservoir *I* by a pipe not shown in the engraving, and the water being heavier than the oil, the

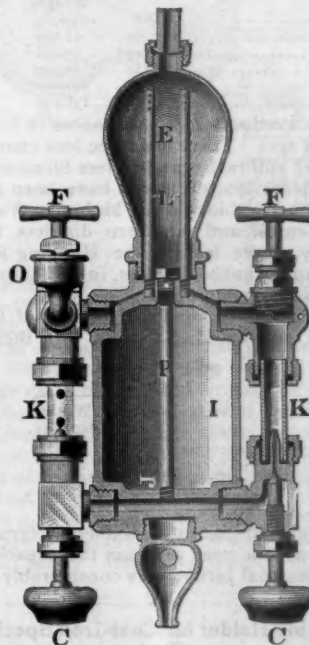


Fig. 428.

former sinks to the bottom of *I*, and the oil floats on top. If the reservoir is half full of water, and is then entirely filled with oil, the water as it condenses in *E* will flow down to the bottom of *I*, and cause the oil to flow slowly into the top of the pipe *P*, and from there down into the channel *J* below *I*, and thence to the glass tubes *K K*, which are filled with water by the con-

* Manufactured by the Nathan Manufacturing Company of 93 Liberty Street, New York.

densation of steam. This flows into them through the pipes *L*. The oil then passes upward, drop by drop, through the water in the tubes *K K*, as shown on the left-hand side of fig. 428, and it then passes by an opening above the tubes to the pipes *H*, one of which is shown in fig. 427, and through them to the steam-chests. The flow of oil is thus constantly in sight, and it can, therefore, be known whether the lubrication is continuous and regular. The pipes *L* inside of the reservoir conduct a small quantity of steam and water to the pipes *H*, after the glass tubes *K K* are filled, and in this way the oil, when it reaches the surface of the water in the tubes *K K*, mingles with the current of steam, which thus forms a steam lubricant that reaches and oils all parts of the valves and cylinders.

The quantity of oil entering the sight-feed glasses *K K* can be regulated by the valves *C C*.

The two sides of the lubricator form two distinct and entirely separate oilers, which work independently for each cylinder. The feed is regular and continuous, whether steaming or with steam shut off, going up or down grade.

Each side is provided with an independent "hand" or auxiliary oiler, *O*, to be used in case any of the glass tubes should break. The auxiliary oilers communicate directly with the pipes *H*, and can be used as simple oilers in case of need. In case one of the glass tubes should be broken, the valve *F* above it should be closed, which will prevent the escape of steam from the broken tube.

Another glass tube, *G*, forms a gauge to show the quantity of oil and water in the reservoir *I*, and a cock, *W*, is used to drain the reservoir *I* before refilling it.

The valve *D* opens or closes the opening which communicates from the condenser *E* to the reservoir *I*. This valve should be closed when the engine has completed its run. If it, the valves, *C C*, and the steam-valve, *B*, are left open, oil will continue to feed into the cylinders so long as there is any steam in the boiler.

(TO BE CONTINUED.)

Manufactures.

Blast Furnaces of the United States.

THE *American Manufacturer* gives its usual tables of the blast furnaces on May 1, and says: "A condensed statement of their condition is as follows:

Fuel.	In Blast.		Out of Blast.	
	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal.....	60	11,951	104	11,170
Anthracite.....	103	35,078	88	29,574
Bituminous.....	139	91,239	87	37,803
Total.....	302	138,268	279	71,547

"This shows a reduction of 10 furnaces in blast as compared with one month ago. There are three less charcoal furnaces in blast, three more anthracite, and 10 less bituminous. The chief changes in the bituminous furnaces have been in Ohio. There is the same number in blast in the Mahoning Valley, one less in the Eastern, Central and Northern districts, two less in the Hocking Valley, three less in the Hanging Rock. In other districts the changes have been less, in some districts one going in and in others one going out.

"The appended table shows the number of furnaces in blast on May 1, 1889, and on May 1, 1888, with their weekly capacity:

Fuel.	May 1, 1889.		May 1, 1888.	
	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal.....	60	11,951	60	11,956
Anthracite.....	101	35,078	104	30,366
Bituminous.....	138	91,239	133	80,230
Total.....	303	138,268	297	122,552

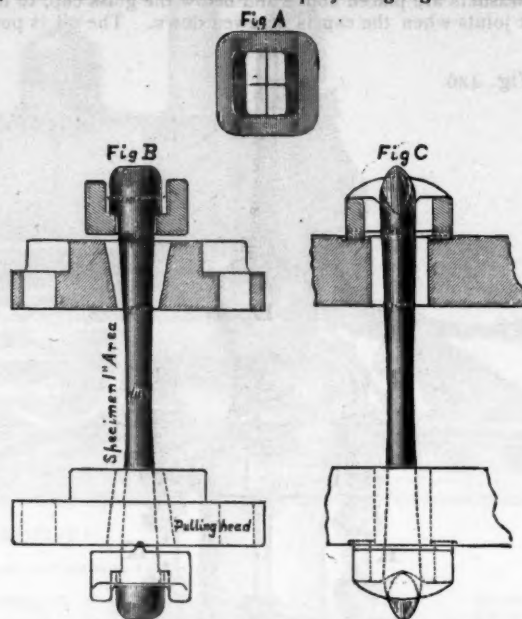
"It will be noticed that the number of furnaces in blast is about the same as one year ago, but the capacity, with the exception of the charcoal furnaces, is considerably greater."

Self-Adjustable Holder for Cast-Iron Specimens Under Test.

THE accompanying illustrations show a self-adjustable holder for cast-iron tensile test pieces, giving also the form of the specimen to be tested. Fig. *A* is a top view and fig. *B* a side view, showing the holder and specimen, while fig. *C* gives inside view of the holder, showing also the position and shape of the specimen under test.

To further explain the form of specimen and method of apply-

ing the test to so brittle a substance as cast iron, we would state that the specimen, as here shown, in one-eighth size, is round and reduced at the center or breaking point to 1.113 or 1 sq. in. area; from the center point the specimen gradually increases in size, and either end is formed with projecting lugs. These lugs



rest on adjustable rocking bearings both above and below, and receive all the strain that is brought to bear upon the specimen. By this method the specimen naturally aligns itself, and the strain applied is received through the central axis and it is not possible for it to be subjected to any twisting or side strain. In view of the fact that cast iron is being subjected to tensile tests so much more than formerly, and of the difficulty that existed in arriving at a fair test without any side strain or even pull, the advantage of such an arrangement is obvious, and will be appreciated by all manufacturers of pig iron who are filling large contracts based upon physical tests, which are found to be as important as chemical tests. Many companies operating blast furnaces are providing themselves with patterns for making these tests, and almost daily, and as often as new ores and new mixtures are used for making iron, are having test specimens cast and forwarded to a physical laboratory of their own, or to the nearest testing laboratory operated by responsible parties. A transverse test can be made from a pattern 12 or 24 in. long, as may be preferred, and 1 in. square.

This holder is a new device made by the firm of Riehle Brothers of Philadelphia, for use in connection with their well-known testing machines.

Steering Vessels by Direct Power.

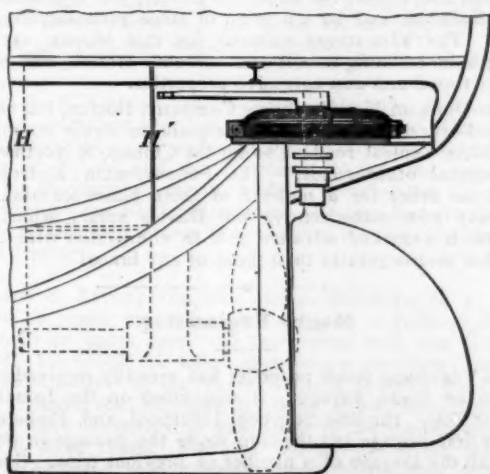
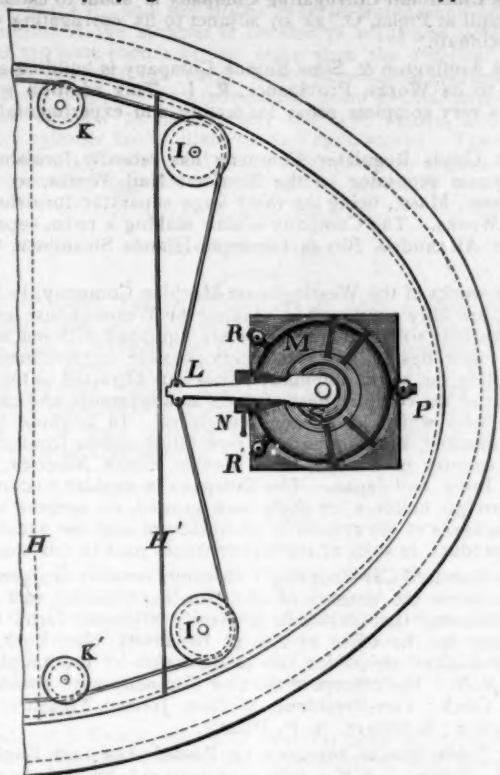
THE ordinary method of steering by hand from a tiller or a rope-drum with a hand-wheel is direct, the power being applied by the helmsman, and it is also reacting. The type of hand-steering gear in which the steering-wheel operates right and left screws and nuts is direct for the helmsman, but not reacting. The different kinds of steam-steering gear heretofore employed work with a worm-wheel and worms; they are not reacting, and can be disconnected at any position of the rudder only when provided with transmission through a friction cone arrangement, which is only used in light service.

To connect a non-reacting steering gear with the rudder—usually by pins—requires the gear to be put in place exactly to meet the holes or sockets for the pins, usually at a central position, and this is difficult to accomplish, if one gear falls outside of that position. For this reason an arrangement in which only one gear is used at a time requires the withdrawal and change of pins at a central position for any change of operating.

Full safety can only be secured when there are two steering gears in connection with the rudder, and when suitable provision is made, so that power may be applied without delay, without removing the pins and at any position of the rudder. Both gears must be reacting, or suited to be moved by and with each other.

A steam-engine for steering a vessel may be started and stopped with precision and perfection, but the momentum of a vessel tends always to keep it on the direct forward course, and the only method of preventing a collision in emergencies is by

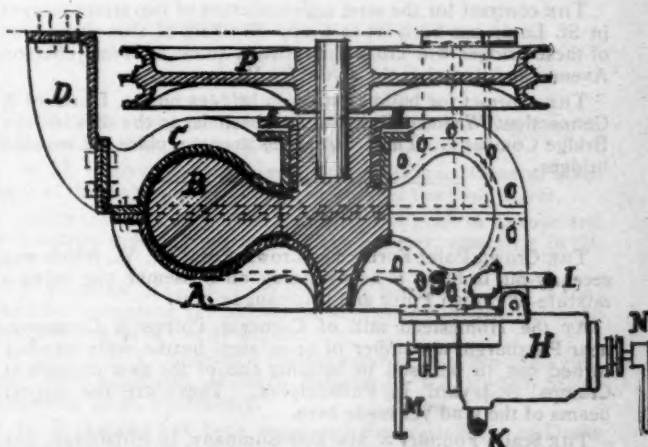
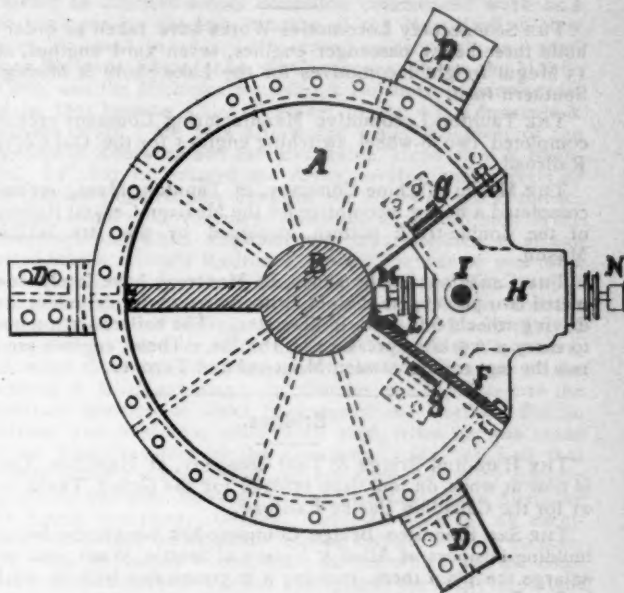
a quick change of the rudder, which requires reliable and powerful machinery. The frequent damage of the rudder and destruction to the steering connections endangers navigation. It is often caused by the rigidity of the steering apparatus, as it is generally constructed, and by the impossibility of any reaction. The accompanying illustrations show a new apparatus for



steering vessels by direct power. Fig. 1 and fig. 2 show the arrangement of this steering system in a vessel; *M* showing the motor; *N* the valve chest; *R R* the relief cocks; *P* the regulator cock, for the brake, and *S* the centering coupling. Figs. 3 and 4 are two views of the motor, or rather of one form of it, for several different forms can be employed to suit different cases.

This motor can be used either with steam or compressed air, and has the advantage that when necessary the change from power-steering to hand steering and *vice versa* can be accomplished instantaneously. This is done by the employment of an additional valve which cuts off the supply of steam to the motor, and at the same time throws it open to the free circulation of the air, so that there is no obstruction to the motion of the piston in its case while the hand-steering apparatus is in use. It is not necessary when the motor is used to disconnect the tiller or other hand-steering arrangement, and the extra valve of the motor is operated by the relief-valve lever, which is placed close at the steering stand, so that the helmsman can make the change at once by a motion of his hand.

The construction will be readily understood from the illustrations given, and it is really very simple. The motor can be made with a single piston or with two or three pistons, as preferred, and can be proportioned to operate at a governed pressure. It can be connected directly to the rudder, or can work with a chain and gear, as may be most convenient. In many vessels, such as tugs and ferry-boats, a pulley motor can be placed under the deck at a convenient point below the pilot-house, and can be attached directly to the main steering ropes leading to the pilot-house. Steam can be used directly from the boiler,



and the motor and pipes can be well covered so as to avoid condensation as much as possible. If they are placed above the water line of the boiler they can be drained directly back to it, while the exhaust steam can be discharged into the water tank, and so utilized for heating the feeding water.

While in some cases compressed air may be preferred for the motor, it is probable that in a majority of instances the expense and space required would be less where steam taken directly from the boiler is used. In this case the connections are simplified, the cost of an air-compressor and reservoir is saved, and the space required for the air-compressor is also saved, which in small vessels may be an important consideration.

This apparatus is the invention of Mr. J. L. Hornig, M.E., and E. S. Wells, Jersey City, N. J., is agent and manufacturer.

Cars.

THE United States Rolling Stock Company is building 23 passenger cars for the Alabama Midland road, at its shops in Hegewisch, Ill. At the same shops they are building 300 coal cars for the Central Railroad of Georgia and 150 ore cars for the Milwaukee & Northern. The Company's shops at Anniston, Ala., are building 200 box and 300 flat cars for the Georgia Southern & Florida.

THE Jackson & Sharp Company, in Wilmington, Del., has

recently shipped passenger cars to the Richmond & Danville, the Alleghany Valley, and the Ulster & Delaware Railroad.

THE Decatur Car Wheel Company, at Decatur, Ala., has recently decided to double the size of its plant.

THE Michigan Car Company, in Detroit, has recently taken the contract to furnish 100 coal and 200 box cars to the Rome, Watertown & Ogdensburg Railroad.

Locomotives.

THE Schenectady Locomotive Works have taken an order to build three heavy passenger engines, seven yard engines, and 15 Mogul freight locomotives for the Lake Shore & Michigan Southern road.

THE Taunton Locomotive Manufacturing Company recently completed two 6-wheel switching engines for the Old Colony Railroad.

THE Mason Machine Company, in Taunton, Mass., recently completed a heavy locomotive for the Mexican Central Railroad of the double-truck pattern, designed by the late William Mason.

THE Canadian Pacific shops, in Montreal, have lately completed two passenger engines, with 20 by 22 in. cylinders, and driving wheels 6 ft. 3 in. in diameter. The boilers are intended to carry a working pressure of 180 lbs. These engines are to run the fast trains between Montreal and Toronto.

Bridges.

THE Hamilton Bridge & Tool Company, at Hamilton, Ont., is now at work on four iron bridges for the Grand Trunk and 21 for the Canadian Pacific Railroad.

THE San Francisco Bridge Company has bought the bridge-building business of Allen & Nelson at Seattle, Wash., and will enlarge the plant there, running it in connection with its works in San Francisco.

THE contract for the steel superstructure of two street bridges in St. Louis has been let to Stupp Brothers of that city. One of these bridges will cross the railroad track at West Jefferson Avenue and the other the river Des Peres.

THE contract for building 21 iron bridges on the Hartford & Connecticut Western Railroad has been let to the Berlin Iron Bridge Company. These structures are to replace old wooden bridges.

Iron and Steel.

THE Crown Point Furnace at Crown Point, N. Y., which was recently put in blast, is now running on Bessemer pig, using a mixture of Crown Point and Chateaugay ores.

At the Homestead mill of Carnegie, Phipps & Company, near Pittsburgh, a number of 24-in. steel beams were recently turned out, to be used in building one of the new cruisers at Cramps' Ship-yard, in Philadelphia. These are the largest beams of the kind yet made here.

THE Scaife Foundry & Machine Company, in Pittsburgh, has completed a new Bessemer steel plant for Miller, Metcalf & Parkin of the same city. This plant will have all the latest improvements.

THE Emaus Pipe Works at Emaus, Pa., are filling a large order for 3-in. cast-iron water-pipe, to go to South America.

THE consolidation of the North Chicago Rolling Mill Company, the Union Steel Company, and the Joliet Steel Company has been completed, the capital stock of the new company having been placed at \$25,000,000. The new company will own the extensive iron and steel works at North Chicago, Bay View, South Chicago, Calumet, and Joliet, besides the blast furnaces in Michigan and other outlying properties. It is stated that the South Chicago mills will be entirely devoted to the manufacture of steel rails, while the other works will be used for other products.

Manufacturing Notes.

THE Pond Engineering Company, of St. Louis, has recently opened a branch office at No. 51, Home Insurance Building, at Chicago. The Company now has offices in Chicago, Kansas City, and Omaha, in addition to the main office in St. Louis.

THE firm of Bradley & Company, Syracuse, N. Y., have recently purchased the business of Beaudry & Cunningham, of Boston, and will hereafter manufacture the Beaudry power hammer in addition to their own hammer.

THE Standard Metal Tie & Construction Company has removed its offices to No. 15 Cortlandt Street, New York.

THE office of Frank H. Andrews and of the Globe Iron & Spring Works has been removed to No. 556 West Thirty-fourth Street, New York City.

THE Cincinnati Corrugating Company is about to establish a sheet mill at Piqua, O., as an adjunct to its corrugating works in Cincinnati.

THE Armington & Sims Engine Company is building an addition to its Works, Providence, R. I. This addition will include a very complete room for testing and experimental purposes.

THE Curtis Regulator Company has recently furnished an 8-in. steam separator to the Tremont Nail Works, at West Wareham, Mass., being the third large separator furnished for those Works. The Company is also making a 10-in. separator for the Alexandria Bay & Thousand Islands Steamboat Company.

THE works of the Westinghouse Machine Company, in Pittsburgh, are fully employed in making the Westinghouse engine in its various sizes. These shops are equipped with machinery of the latest design, and with every possible improvement for facilitating the work, and many visitors are attracted to them on account of the completeness of their arrangements and the improvements which have been introduced. In addition to the home demand, the Company is now filling orders from almost every country in Europe, from Mexico, South America, Australia, India, and Japan. The Company is enabled to compete with foreign builders on their own ground, on account of the thoroughness of its system of manufacture and the excellence of its product, in spite of the higher wages paid in this country.

THE Standard Car Coupling Company, recently reorganized, now controls the patents of the Dowling Coupler, and it is manufacturing that device in a greatly improved form. The Company has its office at No. 45 Broadway, New York, and has established shops for the manufacture of the coupler at Troy, N. Y. The officers of the new Company are: President, E. C. Clark; Vice-President, William Jones; Treasurer, H. H. Burden; Secretary, A. P. Dennis.

THE Tobin bronze, invented by Passed Assistant Engineer John A. Tobin, U.S.N., and manufactured by the Ansonia Brass & Copper Company, is already in use in the Navy, and has been adopted on the Brooklyn Bridge, the Manhattan Elevated Railroad, and by a number of large manufacturing concerns. The advantages claimed for this bronze are great strength in resisting tensile and torsional strains, and marked anti-frictional and non-corrosive properties.

THE Dunham Manufacturing Company, Boston, has recently received orders for the Servis tie-plate, to equip 20 miles of the Maine Central road; also for the Chicago & Northwestern and several other roads. The Pennsylvania Railroad has placed an order for a number of these plates for trial. The Company now manufactures the Davies spike, which, it is claimed, is a marked advance, and in connection with the tie-plate has merits greater than those of any brace.

Marine Engineering.

THE Vogelsang screw propeller has recently received its first test on an ocean voyage. It was fitted on the Inman Line steamer *Ohio*, running between Liverpool and Philadelphia. On the first voyage out the ship made the passage in one day less than the average of a number of previous trips. Some results obtained are as follows: "The *Ohio* steamed up the Delaware from Cape Henlopen to Philadelphia, 100 miles, in 7 hours, against strong tide, with only 120 lbs. steam pressure, and an average of 59 revolutions. Highest steam pressure that can be carried is 150 lbs. With this the engines would run from 68 to 69 revolutions. Pitch of screw, 22 ft. 6 in. The highest speed attained with old screw, 71 revolutions, is 13.5 knots per hour. The highest speed attained with the Vogelsang screw is 15.2 knots, with 68 revolutions."

THE steamer *Puritan*, just completed for the Fall River Line, and which is expected to surpass in several respects her consort, the *Pilgrim*, went on her trial trip May 6 to test her engines. Only the builders of the engines, Messrs. W. & A. Fletcher, a representative of the Old Colony Steamboat Company, and a few personal friends were on board. The *Puritan* went about five miles outside of Sandy Hook, a distance of 25 miles, and returned to her pier, covering the 50 miles in about five hours, or an average of 10 miles per hour. The machinery worked well, but no attempt was made to test the speed. This vessel is the largest in the line, and her estimated cost is

\$1,500,000. Her hull is of steel, built on the double-hull, bracket-plate, longitudinal system, with 96 water-tight compartments. In addition there are six water-tight bulkheads, dividing the hold into seven water-tight compartments. She is supposed to be practically unsinkable. She is 403 ft. long on the water-line, 420 ft. over all, or 30 ft. longer than the *Pilgrim*. Her hull is 52 ft. broad and 91 ft. over the guards. The depth of the hull is 21½ ft., and she draws 13 ft. of water when loaded. The interior of the steamer is finished in white and gold, and she has 350 state-rooms, or 100 more than the *Pilgrim*. It is estimated that she can carry 1,500 passengers comfortably. The boat is propelled by a compound beam engine, with high-pressure cylinder 75 in. diameter and 9 ft. stroke, and low-pressure cylinder 110 in. diameter and 14 ft. stroke. The working pressure is 110 lbs., and steam is furnished by eight boilers. The engines are expected to work up to 7,500 H. P.

Electric Notes.

THE Williams Engine Works are to have a Shaw electric traveling crane for their new shops at Beloit, Wis. It will have a span of 40 ft. and be proportioned for a working load of 15 tons, but is to sustain a test load 50 per cent. in excess of this, or 22½ tons, without injury. It is being built by Edward P. Allis & Company, of Milwaukee, who have had one of these cranes of 25 tons capacity in successful operation in their foundry for several months.

OBITUARY.

ROBERT W. WEIR, who died in New York, May 1, aged 86 years, was trained as an artist and appointed teacher of drawing in the United States Military Academy at West Point, in 1834, and in 1846 was made Professor. After 42 years of service at West Point he was retired in 1876 with the rank and pay of Colonel and has since lived quietly in New York.

WILLIAM J. TRACE, who died May 15, aged 24 years, was at one time with the *Railroad Gazette*, but for several years past had been connected with the *National Car and Locomotive Builder*. Mr. Trace was a young man of excellent ability and thorough integrity, and his early death, at a time when a prosperous and useful career seemed to be before him, will be regretted by many warmly attached friends.

MAJOR A. B. ROGERS, who died in Waterville, Minn., May 4, aged 59 years, had been for 33 years a resident of Minnesota. He was employed as an engineer on the Minnesota Central, the St. Paul & Pacific, and the Northern Pacific, but was best known by his very successful work in locating the Canadian Pacific through the Rocky Mountains, the line laid out by him through the Kicking Horse Pass having been finally adopted by the Company.

ELECTUS B. LITCHFIELD, who died in Brooklyn, N. Y., May 13, aged 72 years, was a prominent figure in railroad circles over 30 to 40 years ago. In connection with his brother, Edwin C. Litchfield, he held many heavy contracts; having built a large portion of the Terre Haute & Indiana, the Cleveland & Toledo, the Michigan Southern & Northern Indiana, and after their construction was active in the management of several of these roads. He also had several street railroad contracts, and was largely interested in the building of street railroads in Brooklyn, and the development of real estate there. For a number of years past Mr. Litchfield has been practically retired from business, doing nothing except to manage his property in Brooklyn.

WILLIAM H. BARNUM, who died at his residence in Lime Rock, Conn., April 30, aged 71 years, was born in Boston Corners, N. Y., and early in life entered into business with his father, who had established an iron foundry at Lime Rock. Mr. Barnum gradually extended his business until he owned all of the charcoal furnaces in Western Massachusetts and Connecticut, and controlled the output of the well-known Salisbury ore. He was the chief owner also of extensive car-wheel works at Lime Rock, and was engaged in many other similar enterprises.

Mr. Barnum was for a number of years prominent in politics, having served in the Connecticut Legislature, in the House of Representatives, and in the United States Senate. In this connection, however, he was best known as Chairman of the

Democratic National Committee, a position which he held continuously from 1877 until his death. He was a prominent member of the American Iron & Steel Association.

GENERAL ADNA ANDERSON, one of the best known railroad engineers in the country, committed suicide May 14, while stopping temporarily at the Lafayette Hotel, in Philadelphia. He had been suffering for some time from brain trouble and it is believed that he was insane at the time of the suicide. General Anderson was born in 1827 at Ridgeway, N. Y., and after receiving an ordinary school education commenced work as a civil engineer on the first location of the New York & New Haven Railroad, in 1847. He served subsequently as Assistant or Resident Engineer on the Connecticut River, the Mobile & Ohio, and the Michigan Southern & Northern Indiana roads, and in 1855 became Chief Engineer of the old Tennessee & Alabama Road. He was afterwards Chief Engineer of the Edgefield & Kentucky and the Evansville, Henderson & Nashville. In 1862 he entered the Army, serving successively as Chief of the Construction Corps of the Army of the Potomac, Superintendent of Government Railroads in the Division of the Mississippi, and Chief Engineer and Superintendent of all the United States Military Railroads. After the war he was for a short time Chief Engineer of the St. Louis Bridge, then for four years General Superintendent of the Kansas Pacific, and for three years General Manager of the Wabash road. In 1875 he was appointed Receiver of the Chicago, Danville & Vincennes, and, when that road was reorganized, General Manager of the Paducah & Elizabethtown. In 1880 he was appointed to the important position of Chief Engineer of the Northern Pacific Railroad and held that office until 1886, when he was made Second Vice-President of the Company. He resigned that position about a year ago and had not since been very actively engaged in business, although he was President of the Auxiliary Fire Alarm Company. General Anderson achieved an excellent reputation as an engineer, having carried through successfully many important works, chief among which was the completion of the Northern Pacific. In spite of the many important positions which he held during his life he died a poor man.

PERSONALS.

J. M. MORRISON has been appointed Resident Engineer at Kansas City, Mo., of the Wabash Western Railroad.

W. M. CLEMENTS has resigned his position as General Manager of the Baltimore & Ohio Lines east of the Ohio River.

JAMES GAMBLE, C. E., of New York, has gone to Europe and will remain there during most of the summer, returning in the fall.

T. WILLIAM HARRIS & COMPANY of New York, have a contract for extending the gas works at Tarrytown, N. Y., to the neighboring village of Irvington.

CAPTAIN E. L. ZALINSKI, the inventor of the dynamite gun, has been appointed Military Attaché of the United States Legation, at St. Petersburg.

H. B. ABBOTT has been appointed Superintendent of Docks of the Lehigh Valley Railroad at Buffalo, N. Y., and will have charge of all transfers of traffic at that point.

HERBERT HACKNEY has resigned his position as Assistant Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad, and has started on a short trip to Europe.

W. I. MCCAMMON has been appointed Master Mechanic of the Mexican National Railroad, with headquarters in the City of Mexico, succeeding Mr. Winslow, who has resigned.

T. S. CHAPMAN has been appointed Superintendent of Motive Power of the Central Railroad of Georgia, with office in Savannah. He was formerly on the Chesapeake & Ohio.

J. T. ODELL has been appointed General Manager of the Baltimore & Ohio Railroad. Mr. Odell has had much experience in railroad management and has served on the Kansas Pacific, the Northern Pacific and other roads.

H. A. LITTLE has severed his connection with the Safety Car Heating & Lighting Company and is now with the Strong Locomotive Company of New York, which he will hereafter represent, with his usual ability, and, we trust, with his usual success.

W. W. PEABODY is appointed General Superintendent of the Baltimore & Ohio Lines west of the Ohio River and General Agent for the Company in Chicago. He has been for a long time connected with the Baltimore & Ohio System in different positions.

PROCEEDINGS OF SOCIETIES.

American Society of Civil Engineers.—At the regular meeting, May 1, a plane-table, made in 1656, and used by George Washington was exhibited. It is now the property of the Society. Mr. J. J. R. Croes presented a minute on Washington's work as a civil engineer. President Fieley read the Centennial address of the President which he had signed on behalf of the Society. It was announced that the Annual Convention at Seabright, N. J., would probably open June 20.

The paper of the evening was on the Fresh Water Algæ and their Relation to the Purity of Public Water Supplies, by George W. Rafter, Rochester, N. Y. Professor Albert X. Leeds, of the Stevens Institute, followed with some remarks on the same subject, and the discussion was continued to the next regular meeting.

The Tellers announced the following elections:

Members: Charles J. Bates, New York; Cornelius C. F. Bent, Joseph Ramsey, Jr., Cincinnati; Charles T. Church, Saratoga, N. Y.; Charles S. Churchill, Roanoke, Va.; Harry Frazier, Henderson, Ky.; George P. Hilton, Albany, N. Y.; Howard G. Kelly, Washington; George N. Merrill, Stanfordville, N. Y.; Andrew W. Munster, St. Paul, Minn.; James E. Willard, West Point, Ky.

Associate: William L. Abbott, Pittsburgh.

Juniors: John N. H. Cornell, New York; W. E. Crane, Alfred B. Allsworth, Pittsburgh; Oscar Erlandsen, Poughkeepsie, N. Y.; William L. Ferguson, Philadelphia.

THE following circular has been issued to members by the Secretary, under date of May 9:

"The Convention will be held at Seabright, N. J., beginning on or about June 20, 1889. Seabright is on the Atlantic Coast, a few miles north of Long Branch, and within about an hour's time from New York by boat or rail.

"Arrangements as to transportation are in progress with the Passenger Associations and Committees, whereby it is expected that a rate of one and one third full fare will be made for the round trip from all points on the lines of the roads represented by such Association.

"You are invited to contribute papers or discussions on papers already published. A concise abstract of any paper to be presented should be sent to the Secretary not later than May 31. This will make discussion more probable, as a copy of the abstract will be sent to members who may be expected to contribute discussion.

"Please advise the Secretary if you will contribute a paper, or discussion on special subject."

At the regular meeting, May 15, the subject for discussion was Mr. Rafter's paper on Fresh Water Algæ and their Relation to the Purity of Public Water Supply, which was continued over from the previous meeting.

American Society of Mechanical Engineers.—The spring meeting of this Society was held in Erie, Pa., beginning May 14, when the usual addresses of welcome were made and an address delivered by ex-President Horace See, the meeting being followed by a social reunion.

On May 15 there was a business session at which the reports of the officers and Council were presented and a number of papers read; and in the afternoon the members visited the Erie City Iron Works and other manufacturing establishments. In the evening a second session was held for the reading of papers and topical discussions.

On Thursday morning a session for reading papers and topical discussions was again held. In the afternoon more visits were made to manufacturing establishments, including the Ball Engine Company, the Watson Paper Mill, and others. The evening was devoted to a reception tendered by resident members and friends to the visiting members and their ladies.

On Friday the meeting ended with a session for reading papers and discussion and a short business session for transacting the usual routine business. After this the meeting concluded with a sail upon Lake Erie and a visit to the Erie Water-Works, closing pleasantly a very successful meeting.

United States Naval Institute.—An interesting and instructive paper was read before the Naval Institute, at Annapolis, May 17, by Mr. S. D. Greene, a former officer of the Navy, entitled Electricity on Board War Ships.

The object of the paper was to bring to the notice of naval officers the extent to which electricity is being used for the transmission of power for commercial purposes.

One of the latest electrical devices described by Mr. Greene was the new range-finder, invented by Lieutenant Fiske. Its

accuracy, as proved by elaborate tests, is something remarkable, and its general usefulness on board ship for taking bearings, distances, angles, etc., will be readily appreciated by all interested in the nautical profession.

The Engineers' Club.—The new house of this Club, No. 10 West Twenty-ninth Street, New York, was opened by a reception on April 27. The Club has now 350 members, and the Treasurer reports a balance in the treasury of about \$14,000.

Engineers' Club of Philadelphia.—At the regular meeting of April 20, the Secretary presented a letter from Mr. Samuel T. Wagner on Standard Rivet Symbols.

The Secretary presented, for Mr. H. A. Vevin, tracings and description of six Gallows Frames, erected at mines near Leadville, Col.

Professor H. W. Spangler described an instrument for Summing up the Lengths of Lines, consisting of a pair of dividers with a registering device attached. He explained its use in determining the area of indicator cards, by dividing the card into vertical trapezoids of equal width, obtaining the aggregate of the average height of each with these dividers, and multiplying by the width.

At the regular meeting, May 4, the tellers announced that all the votes cast upon the proposed amendments to the Constitution failed to pass.

Mr. J. E. Codman presented a table of dimensions of Pipe Flanges and Cast-Iron Pipes for the *Reference Book*.

A paper on Color, by Mr. Robert A. Cummings, was presented by the Secretary.

Mr. Arthur Marichal called the attention of the Club to a paper read before the Society of Civil Engineers of Paris by M. Decordemoy, in which he describes the Recent Improvements of the Harbor of Bilbao, Spain. This was discussed by Professor L. M. Haupt and others present.

Professor Lino F. Rondinella explained two Diagram Tables, one of which gives graphically the relations of lines and areas in polygons, and the other the relation between English and metric measurements.

Western Society of Engineers.—At the regular April meeting in Chicago, John S. Glenn was chosen a member. The Committee on Permanent Quarters made a report announcing that they had leased rooms, which was received. After a long discussion on the financial condition of the Society, it was resolved to increase the annual dues to \$10. A committee was appointed to propose amendments to the constitution and by-laws.

Resolutions were passed congratulating Mr. D. C. Cregier, a member and former President of the Society, on his election as Mayor of Chicago.

Engineers' Club of St. Louis.—At the regular meeting, April 17, the Chairman announced the death of Colonel Henry C. Moore, one of the oldest members and a former President of the Club. He also announced that President Meier had volunteered to prepare a memoir, which he expected to be able to present at the next regular meeting.

Professor Charles C. Brown's paper on the Sanitary Condition of the Water-Supply of New York City was then read by Professor Wheeler. Professor Brown, being Engineer of the New York State Board of Health, had devoted considerable time and study to the subject.

Messrs. Holman, Bryan, Wheeler, Thacher, Ferguson, and Bouton took part in the discussion.

The Secretary then read a paper by Mr. A. J. Frith, describing a system of marking patterns. The question was treated in detail, and the desirable points explained. A sample record sheet was submitted. Mr. Frith also submitted a brief discussion of economy of manufacture as viewed in the pattern.

Mr. Crow described a system of marking small patents, which had been in use very successfully.

At the regular meeting, May 1, C. H. Howard and Pope Yeatman were chosen members. A resolution was passed providing for a standing committee to prepare for publication a book containing information with regard to the materials for engineering in use in St. Louis and vicinity, another memorandum of a local nature, useful to engineers.

Professor H. B. Gale then read a paper on a new theory of Chimney Draft and the design of Brick and Iron Stacks. The author had made numerous experiments to determine the different factors which entered into the problem, and gave some formulæ in shape for convenient use. The difference between brick and iron stacks was discussed. He showed that while the

area of a stack could not be reduced below certain limits, it could be increased without affecting the efficiency of the stack. Professor Johnson, Mr. Holman, Mr. Laird, Nils Johnson, and Mr. Bryan took part in the discussion.

At the regular meeting, May 15, T. J. Long and O. H. Schramm were elected members. President Meier read a memoir of the late Colonel Henry C. Moore, ex-President of the Club.

Mr. J. A. Seddon read a paper describing experiments he had made concerning the Settling of the Water in the settling basins of the St. Louis Water-Works. The discussion of this paper was made special order for the next meeting.

Professor J. B. Johnson presented a paper on Trussing a Large Building in St. Louis against Wind Pressure, which was discussed by Messrs. Holman, Moore, and Flad.

Professor F. E. Nipher made a valuable report on a recent investigation into the performance of an engine working at a fixed cut-off without governor. Measuring the brake horsepower, the pressure of the supply steam and the speed, he finds that the performance of the engine is represented by a hyperbolic paraboloid, in which the lines of constant load and the lines of constant speed are rectilinear elements. At any fixed pressure the relation between output and speed is represented by a parabola, the vertex of which represents a condition of maximum output. This was discussed by Messrs. Holman, Gale, and Flad.

Engineers' Club of Kansas City.—At the regular meeting in Kansas City, May 6, Robert A. Crawford was elected an associate member.

The Committee on the Transfer of Members presented a final report. It was thought that the decision on any scheme should rest with the Board of Managers of the Association; that local societies of acknowledged standing should be invited to cooperate; and it was recommended that our Representative be requested to lay the matter before the Board.

It was voted that a copy of the report be laid before the Board of Managers of the Association of Engineering Societies.

A standing Committee on Cements and Mortars was appointed, consisting of Messrs. D. Bontecou, W. D. Jenkins, and E. Saxton. A special committee was also appointed to make arrangements for the annual summer excursion.

A paper on the Foundations for the Limfjord Bridge was read by Mr. O. F. Sonne. The bridge was built in 1874-78 across the Limfjord, near Aalborg, for the Danish State Railways; it has four spans of 206-226 ft. and two draw spans of 88 ft. each. The piers were sunk by the pneumatic process through soft and tenacious mud, one of them to 59 ft., the six others to 111.55-113.50 ft.; they were built with iron caissons, the masonry of hard-burned brick laid in Portland cement, the upper part protected by granite; they were lowered from scaffolds and kept suspended, during the sinking, each by four rods or chains hooked around the cutting edge. Through a combination of circumstances one of the piers was overturned and it located on the center-line of the bridge; a new pier was lowered and had to be carried through the old one. The work was done under contract by a French firm, the Compagnie de Fives-Lille.

Denver Society of Civil Engineers & Architects.—At the regular meeting in Denver, Col., May 7, the greater part of the meeting was devoted to the discussion and adoption of a new Constitution and By-Laws. The Society desired to discuss these matters thoroughly, in order to avoid some of the pitfalls into which other technical associations have fallen. The Constitution contains some changes from most of those of similar Societies. For instance, nominations for officers are made in open meeting a month before the election; as many candidates are named for each office as members wish, and these nominations may be also by letter.

Major J. W. Powell, Director of the United States Geological Survey, was elected an honorary member.

The officers of the Society are: President, E. S. Nettleton; Vice-President, R. A. Wilson; Secretary and Treasurer, W. W. Follett; Executive Committee, the President, the Secretary, Professor P. H. Van Diest, F. E. Edbrooke, and R. D. Hobart.

New York Railroad Club.—A special business meeting was held in New York, May 6, at which it was resolved unanimously to hold the annual banquet at Delmonico's in New York, on the evening of May 23. A committee of arrangements was appointed and it was expected that the dinner would be a notable one; prominent railroad men were expected to be present and to make addresses.

Western Railway Club.—At the regular meeting in Chicago, May 21, the subject for discussion was the Rules of Inter-

change, with a view to suggesting amendments to those rules to be made at the coming convention of the Master Car-Builders' Association.

New England Railroad Club.—The regular meeting in Boston, May 8, was devoted to the discussion of the Master Car-Builders' Rules for the Interchange of Cars. Messrs. Adams, Marden, Lauder, Fletcher, and others took part in the discussion, in which a number of points were brought up, and amendments were suggested to be presented at the Convention.

Master Mechanics' Association.—A circular of inquiry has been issued by the Committee on Driver Brakes, requesting information on the use of such brakes of various patents. The Chairman of this Committee is Mr. Charles Blackwell, Savannah, Ga.

The Committee on Boiler Covering also issued a circular requesting experience and opinions on the Best Method and Material for Covering Locomotive Boilers. The Chairman of this Committee is Mr. G. W. Stevens, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railroad, of Cleveland, O.

Another committee circular asks for information as to the Best Proportion of Flue and Grate Area in Locomotives, for burning bituminous coal. Answers to this circular are to be sent to J. Davis Barnett, Grand Trunk Railway, Stratford, Ont.

Master Car-Builders' Association.—President William McWood has issued the following circular to members:

"I regret to inform you of the resignation of Mr. M. N. Forney from the position of Secretary of the Master Car-Builders' Association. Considering Mr. Forney's long connection with the Association, and the valuable services rendered by him for some years as Secretary, you will with me feel the loss the Association sustains in his resigning so important a position, and I am sure that I only echo the sentiments of the Executive Committee in suggesting resolutions expressing the appreciation of the Association for Mr. Forney's very satisfactory services, to be presented at the next Convention by the Executive Committee.

"In connection with the Secretaryship, I am pleased to inform you Mr. John Cloud has accepted the position, and from his well-known ability I am sure you will agree with me that the Association has been fortunate in securing his services.

"Mr. Cloud's address is Buffalo, N. Y."

At the meeting of the Arbitration Committee, held in Chicago April 24, the following action was taken:

"Rule No. 30 of the Code of Rules of the Master Car-Builders' Association requires the Arbitration Committee to ask from its members by circular suggestions of changes, amendments and additions to these rules, who shall revise and formulate such replies as they may receive, for presentation to the Association at the next regular meeting.

"In accordance with the above rule, it was resolved that the Committee respectfully requests the railroad clubs to offer such suggestions relative to amendments as they may see proper to make.

"The Committee will be glad to receive suggestions also from any individual member of the Association.

"As the time of the meeting of the Association is very close at hand, prompt attention to this matter is respectfully requested."

Communications should be sent to F. D. Casanave, Chairman, Fort Wayne, Ind.

NOTES AND NEWS.

Rapid Electric Transit.—Mr. John T. Williams has recently exhibited in Boston what he calls the "Portelectric System" of transportation for letters and small packages. The model shown consisted of a track some 50 ft. long, with an up-grade of 6 in. to 100 ft. upon wooden posts about 3 ft. high. On this track was the car, which is about 4 ft. long, and weighs, in this particular instance, 56½ lbs. Around the track, in vertical planes at right angles to its length, were coils of wire every two feet. They were covered so that the wire was not visible, and formed, as it were, a series of rings through which the car passed. The car ran on a single track, had a wheel at each end, and was kept in position by a guide rail over the top. The track itself formed one part of the electric circuit, and the wire in the coils, which were all connected, formed the other. The car itself was a great magnet. Power was obtained by sending a current of electricity through the circuit. This was the whole apparatus.

The bottom fact in it is what has been known for many years,

that an insulated coil of wire has an attractive force or suction for a magnet, and that it will draw a magnet of not too great size directly within it till it is exactly at the center. It is this knowledge applied which is the essential thing in the "Port-electric System." The first coil of wire is made stronger than the others, in order to start the car from its position of absolute inertia. The apparatus is so made that the suction of the coil draws the car within it, but just before it reaches the center, by automatic action the current is cut off and the motion of the car continues. Then it is within the attractive force of the second coil. This is made in the same way. The retarding action of the coil is again cut off, and only the drawing power is permitted to work. As the car is 4 ft. long, and as the coils are only 2 ft. apart, it will be seen that the front end of the car is within the influence of the next coil, while the middle of the car is directly at the center of the coil it has just reached. So the car is constantly subject to the onward motion.

The inventor claims that the car may be made to hold, say 10,000 letters, and can be run from Boston to New York in two hours. Stations could be established along the route for furnishing the electrical force which might be needed. Mr. Williams said in his explanation that probably five stations would be needed between Boston and New York. Mails could be easily transported with great speed and at small cost. Only as much power as was needed would be used, for the invention would automatically return to the station all of the power which was not needed. The expense of the system could be reduced by having the coils further apart. Perhaps they need not be nearer to each other than 20 ft. The length of the car might be increased to 10 or 12 ft. The size of the apparatus might be increased with an increase of its speed and efficiency. Instead of being limited to the carrying of mail matter and packages, he thought that the apparatus might be enlarged so as to carry a person and very probably several persons at once.

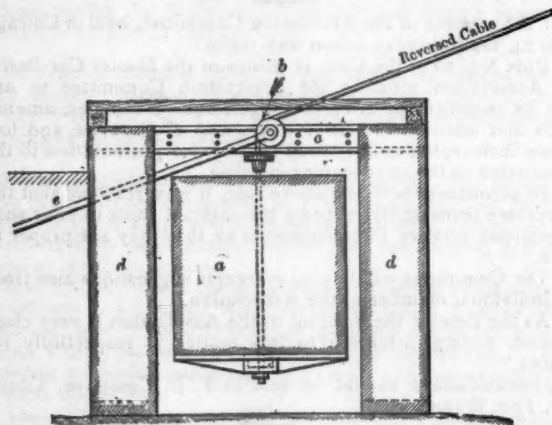
A New Feature in Suspension Bridges.—The Pacific Bridge Company has finished this winter a Suspension Bridge at Oregon City, Or., of 820 ft. length, with a span of 466 ft. between towers.

The clear height for navigation is 75 ft., and the towers are 90 and 100 ft. high respectively.

Special care had to be taken in designing and constructing the bridge, as the floor for the whole bridge is on a grade of 1 in. in 20 ft.

As usual with such kind of work, a great deal of it had to be done from carriages supported from the cables.

A novel feature, and one that is said to be entirely new, is



the introduction of self-adjusting or counter-balanced reversed cables, to materially add to the stiffness of the bridge.

The extreme ends of the cables, instead of being anchored in definite position, are attached to concrete blocks as shown in sketch—which weigh about 10,000 lbs. each, running over wheels *b*. The wheels are supported by iron beams *c*, resting on the walls of a shaft *d*. The concrete blocks or counter-weights, being able to move up and down, keep the cables always under a constant strain to the amount of the weight of the block, which overcomes all vibrations caused by teams, and prevents crystallization of the cables.

If, however, a heavy wind should produce a strain in the reversed cables greater than 10,000 lbs., such an additional strain is transferred or taken up by the special anchors *e*, which are carried back and anchored in the rock.—*Pacific Lumberman and Contractor*.

The Brooklyn Bridge.—At a meeting of the trustees held May 13, it was decided to increase the terminal facilities by enlarging the stations, widening the platforms and stairways, and

laying additional tracks, the total estimated cost of the improvements to be \$409,000, of which \$259,000 will be required for the property taker.

In the three days covered by the Centennial celebration in New York, 588,111 people crossed the bridge, of whom 453,329 were carried in the cars.

Detroit River Bridge.—The Commission of engineer officers, appointed by the Secretary of War, has held several sessions in Detroit, to consider whether the construction of a bridge is practicable. Mr. Gustave Lindenthal announced that he would submit plans for a bridge to consist of two stone piers connected by a central span 1,095 ft. in length. The spans leading from the piers to either shore are to be 787 ft. long. The main roadway of the bridge is to be 135 ft. above the water, permitting the tallest masts to pass underneath. The towers are to be 295 ft. above the level of the water, and 100 ft. below, extending down to the rock foundation. The approaches to the bridge are to be over a mile long. It was estimated that the total cost would be \$6,500,000.

There is also a proposition to build a low bridge for winter use, whose central spans could be removed in summer; and tunnels are also talked of.

A Great Dry-Dock.—The new dry-dock at Newport News, Va., built by J. E. Simpson & Co., of New York, for C. P. Huntington and associates, under the supervision of Francis Collingwood, C. E., was formally opened on April 24, by docking the monitor *Puritan* with suitable ceremonies, which were concluded by a banquet.

The Simpson Company is building docks in Norfolk and Brooklyn, and will soon begin a dock at Philadelphia for the Government. C. B. Orcutt is the President of the Chesapeake Dry Dock & Construction Company at Newport News. The Southwark Foundry & Machine Company, of Philadelphia, built all the pumps and machinery for the dock, which can receive vessels with cargoes on board and drawing 25 ft. of water.

The dock is 600 ft. long from coping at head of dock to outer sill; 130 ft. wide at top and 50 ft. at the bottom, and 33 ft. deep, with a slope in the bottom of 24 in. to the 560 ft. The approach to the dock is 150 ft. wide, between two pile piers—one 80 ft. wide and 250 ft. long on the south, and one 60 ft. by 250 ft. on the north. The caisson is an iron structure, 96 ft. long on top, 50 ft. at bottom, and 33 ft. deep, and with an extreme width of 20 ft., and has eight culverts, 22 in. in diameter, for filling the dock, and two, 18 in. in diameter, for use in sinking the caisson. It is provided with steam power for pumping out the water ballast, a 6-in. centrifugal pump and a steam capstan.

The dock is supplied with two 40-in. centrifugal pumps of a capacity of 44,000 gallons per minute, the two together emptying the dock in 1 hour, 37 minutes, the contents being about 8,500,000 gallons. These pumps have disks 5 ft. 6 in. in diameter, suction pipes 42 in. in diameter, and ejection pipes 40 in. The pumps are admirably designed. The main engines are vertical, and attached directly to the pumps. They have 24 × 24-in. cylinders, phosphor-bronze bearings, and a variable cut-off, working readily up to 145 revolutions per minute. Their combined power is 500 H. P.

There is also a 12-in. centrifugal drainage pump with separate boiler. The main boilers are 13 ft. in diameter and 11 ft. long, with three internally fired furnaces, each 3 ft. in diameter, with 90 tubes 3½ in. in diameter.

The dock is as "tight as a bottle." One of its great advantages is the small rise and fall of tide, which is but 2 ft. 8 in., so that at low tide 22 ft. 4 in. can be carried over the inner sill, thus allowing a vessel to be docked at all stages of tide. The shipyard adjoining will give every facility for making repairs of all kinds and for ship building, and the location so near the stormy Cape of Hatteras should bring an abundance of business.

An Alloy of Steel and Copper.—Schneider & Company of Creusot, France, have taken a patent for a process, which consists in making, either in crucible or by open-hearth process, steel alloyed with a variable proportion of copper. The patent covers also the application of this metal to the manufacture of guns, armor plates, projectiles, and other war material; also the plates, bars, etc.

To make this copper-steel they use ordinary copper or a cast copper, taking care to avoid the oxidation of the copper before it unites with the steel. With this object the copper is introduced either at the beginning of the melting in the interior of the steel, both which is covered by a layer of slag, or near the end of the heat at the moment when the carbonizing elements are added. In this way they obtain steel alloyed with from 2 to 4 per cent. of copper, which has, it is claimed, remarkable qualities of elasticity, resistance, and malleability.—*Revue Scientifique*.